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## BACON'S COLLEGE OF RESEARCH[1]

IT is a common trick of the human mind to estimate the progress of science in a sort of backward survey, reversing the perspective glass of history by turning its eye-piece away from the observer. We unconsciously project into the record the connotations of a later experience and thus distort its true values. The process is as prejudicial to our judgment as it is flattering to our vanity. This is what Sir Henry Wotton means when he says, "we are extremely mistaken in the computation of antiquity by searching it backwards."

Nowhere is the computation of antiquity backwards more fatal to a clear understanding of the past than in dealing with language. We think of Shakspere, for example, not as employing the English of the early 17th century, the only English that he could possibly know, and doing it with a fullness and accuracy that has never been surpassed by any of the great masters of human speech; we think of him as patiently endeavoring to clothe his resistant genius in the connotations of twentieth-century English, and hitting them not quite happily.

So it is with Bacon. We think of him as attempting to formulate science in the terms of our modern concepts, and project into his words scientific connotations that were not born until a century later.

Let us, then, on this three-hundredth anniversary of the publication of a book which revolutionized scientific method and set in motion a "new Philosophy," whose infant society of a handful of enthusiasts was to be the parent of great scientific organizations like the British and American Associations for the Advancement of Science—let us, then, take 1623 as a bench-mark for our theodolite and make a forward survey of the "proficience and advancement" that learning has achieved during the last three centuries.

Putting ourselves in Bacon's position at the beginning of the seventeenth century and surveying the then state of learning through his eyes, we find an intellectual system that is based upon Plato and Aristotle. These great thinkers, master and pupil, had assumed as the foundation of knowledge certain self-existent and predetermined principles—Plato calls them "ideas," Aristotle, "forms"—which it was the business of nature to illustrate and of man to realize. Plato had concerned himself chiefly with the manward relations of his "ideas," and organized them into

[1] A paper read before Section L of the American Association for the Advancement of Science on the 300th anniversary of the publication of Bacon's *de Dignitate et Augmentis Scientiarum*, December 31, 1923.

a system of philosophy: Aristotle had chiefly devoted himself to an organization of the nature-ward aspects of his "forms," and organized them into a system of science.

It was this philosophy and this science, with all the subsequent elaborations of the Middle Ages, that Bacon found intrenched in the universities. The former, however, dealing with causes, was then called "science."[2] The latter, dealing with effects, was called "philosophy," and Aristotle, from the 14th to the 17th century, was styled "the philosopher" *par excellence*. Curiously enough, in the last three centuries the two words have just reversed their connotations.

In the Aristotelian science the *organum*, or tool of knowledge, was the syllogism; and to impugn the efficacy of the syllogism as the instrument of ultimate knowledge was in the 17th century to fly in the face of God himself. That Bacon should dare to do it while yet an undergraduate at Cambridge is evidence of the splendid audacity which always characterized his thinking. To project a new point of view when the world is prejudiced against it and "with loud clamor hooteth the projector, this is not an undertaking for dullness or cowardice." And Bacon's mind, "beating out its own way in untravelled places," never lacked the courage of its convictions.

His first step on the new path, taken in his young Socratic faith that all men would follow the truth once they caught a glimmer of its light, he enthusiastically termed *Temporis Partus Maximus, i.e.*, "The Greatest Thing that Ever Happened." Fancy the effect of a title like that on the staid sensibilities of an Oxford or Cambridge don as he confronted it for the first time staring at him from the shelves of a university bookstall. No wonder Bacon never achieved an academic degree! Even his later admirers were shocked at the audacity of this title. Archbishop Tenison, in "An Account of all Lord Bacon's Works" (1679, p. 9), has this to say of the *Partus* (later absorbed in the *Instauratio*): "That book (pompous in its title but solid in its matter, like a great feather put sometimes on a good headpiece) contained in it, though in imperfect manner and so far as the greenness of his years permitted, the principal rudiments of his Instauration—a work so vast and complete that—it seemeth true that he framed the whole model of the House of Wisdom." (Note this phrase, "the House of Wisdom," the *Aedes Salomonis:* it is Bacon's name for his college of research, which we shall concern ourselves with shortly.)

In like manner all Bacon's titles were calculated to insult the complaisant mediocrity of the academic powers that then were—as he himself puts it, they "fly high over men's heads." His works are always sounding the triumphant note of discovery—the *Novum Organum Scientiarum* ("The New Instrument of Knowledge"), the *Parasceve* ("The Passover Preparation"), the *New Atlantis* ("The Lost Continent Found Again"). And they are written *in verbis masculis*—no "flourishing or painted words, but words such as are fit to go before deeds."

He later lost his faith in the open-mindedness of humanity, but he never lost the conviction that he was on the right path, and never faltered in the courage necessary to pursue it. The goal toward which he consistently pressed all his life long was a new world enriched by the fruit of an organized scientific research systematically proceeding, discovery by discovery, to the ultimate fullness of truth.

Ever practical, with this end in view he undertook a complete survey of the state of human knowledge in 1605. The result of his labors he dedicates to his scholar-king, James I, under the English title "The Proficience and Advancement of Learning." With our habit of "computing antiquity backwards" we quite miss the significance of this title. For in the 17th century "proficience" may mean "worth," "practical value." That this was the meaning Bacon had in mind is obvious from his corresponding Latin title, *de Dignitate*. His purpose in writing the book was thus practical; not academic—***to demonstrate the value of science in the service of humanity and point out the means by which this value might be progressively enhanced.*** His survey covers the whole field of human knowledge at the beginning of the 17th century.

He finds most of the contemporary sciences dry and barren—*deficiens*.

It may be of interest to note in passing that he has no fault to find with the science of language. The two divisions of this ***rational knowledge*** (which is his term for what we think of as "applied science") are grammar and literature, with poetry as the highest form of the latter. Bacon's conception of language was the then prevailing, and not yet quite extinct, view of Aquinas. God gave it to Adam in the Garden of Eden as a means of naming things. Man perfected it until the awful disaster of Babel. Bacon naïvely maintains that man has partially recovered from the effects of his "second curse," as it was known among the schoolmen, by adopting the comparatively perfect language of the Latins as a means of universal communication.

A scientific conception of language was not to dawn on the world until the end of the 18th century through the patient labors of such scholars as Hickes and Junius; its fundamental laws were not to reach a definite formulation until 1822 with Jacob Grimm's discovery of the Germanic Sound Shift; its "proficiency" as a science was not to be formally recognized until the present Year of Grace, 1923.

[2] Milton's Eve, when she first discerns the knowledge of good and evil on eating the forbidden fruit, apostrophizes the apple as the "mother of science" (P. L. IX, 980).

Proceeding in his relentless logic Bacon inquires into the cause of the deficiency he has pointed out. He finds it in the universities with their inevitable tendency to sacrifice the original mind to the exigencies of the academic system.

The second book of the "Proficience and Advancement" is worthy our careful attention as clearly demonstrating Bacon's conception of the proper place of research in university education. He finds (p. 95) that the great universities are "dedicated to professions, and none left free to arts and sciences at large." This frantic pursuit of professorial and professional learning, he says, is the folly described in the ancient fable of the idle stomach and the active members. "If any man thinks pure science to be an idle pursuit he fails to realize that from thence is all applied science supplied." He maintains that this neglect of pure science in the universities is the "great obstacle that stands in the way of the advancement of science," because, in consequence of it, "fundamental knowledges are studied but in passage"—*i.e.*, the sciences that are fundamental to progress are studied only superficially. "If you will have a tree bear more fruit than it hath used to do, it is not anything you can do to the boughs, but it is the tilling of the earth and the supplying of fresh energies to the roots that must worke it."[3]

The pursuit of these professional ends, Bacon goes on to say, produces college professors who are quite unfit for intellectual leadership; they are not "able" (*virile* in modern English) and "sufficient" (our modern *efficient*) men, but the kind that easily submit to authority and tradition. The professorial class, he maintains, should be selected and set apart with a view to breeding the intellects of the coming generation. They should therefore be men who are conspicuous for intellectual virility and vigor. But their present mode of selection defeats this purpose. For the "smallness and meanness" of its rewards and emoluments as compared with those attainable by the practice of other professions is such that an academic career holds out no attractions to induce virile men to devote their entire energies and whole lifetime to it; and the consequent imbecility propagates itself into succeeding generations, so that the devitalized children reflect the starved features of their fathers—

Et Patrum invalidi referent jejunia nati.

Another deficiency Bacon points out in the universities of his day is their reliance upon text-books, and their failure to provide adequate facilities for research in the way of laboratories, botanical gardens and other instrumentalities of investigation (p. 97). Those in authority refuse to authorize the bills of expense, necessarily large, which the provision of such tools renders necessary. With that peculiar aptness of pointed analogy which characterizes his thinking, Bacon maintains that research is the intelligence department of organized knowledge, and that scientific investigators are the "espialls and intelligencers" of nature. When a government cuts down the bills of its intelligence department it puts out its own eyes, and as a consequence is ill advertised of the plans and movements of its enemies.

As to text-books, the situation is to be met not by ceasing to produce books, but "by making more good books."

Another weakness in the contemporary institutions of higher learning, he maintains, is the admission of students immature and untrained in the processes of scientific thinking (p. 99); in catering to the capacity of these immature students, knowledge "is made almost contemptible, and has degenerated into childish sophistry and ridiculous affectation"; and the precocious pupils develop the superficiality characteristic of the capacity of children.

Bacon stigmatizes still another deficiency in the universities of his time in their lack of mutual understanding and sympathetic aims and ideals—"intelligence mutual, contract and fraternity"—and their waste of energy and duplication of effort consequent upon a lack of cooperation and coordination—"conjunction of labors."

On page 215 he reaches his final conclusion that there is no health in these institutions because they forestall research; they have abandoned this road and walled it up—it has become a *via deserta et interclusa*. With a lawyer's shrewdness he points out the fact that the fundamental contract of these university societies is one by which the parties agree to hoodwink each other.

> 'As knowledge is now delivered there is a kind of contract of error between the deliverer and the receiver. The one desires to present his knowledge in such a way that it will fit in with established opinions, and not in such a way that it may be tested by actual experience; the other desires immediate satisfaction rather than stimulus to further enquiry—to believe without qualification rather than to ascertain the truth through his own efforts. Thus regard for his reputation makes the Master conceal his ignorance, and mental inertia keeps the disciple from liberating his own intellectual energies.' (Adv., p. 215.)

Bacon's magnificent program for establishing research as the means of regenerating learning in the service of humanity followed two lines: one to provide the scientific method for the *magna instauratio;*

[3] Pasteur's later words, "There exists no category of the sciences to which the name applied science could rightly be given; we have science and the application of science, *which are united together as the tree and its fruit,*" sound like an echo of Bacon's.

the other to provide the material and personnel to make it effective.

The former task proved greater than he had anticipated, but was at last accomplished in his 59th year with the publication of the *Novum Organum* in 1620. In 1623 he incorporated the new system in an enlarged and extended Latin version of the proficience and advancement, under the title *de Dignitate et Augmentis Scientiarum*, bringing the New Philosophy to a point.

We are apt to take this book out of its context and compute its significance backwards. But when we look at it with the eyes of Bacon's contemporaries we can easily realize how an arraignment of the intellectual life of the time as shrewd and relentless as this was should raise for its author such a host of implacable enemies that he would have little opportunity to carry out the second part of his program. And that was what happened. Six years later their animosity culminated in the tragic triumph which broke Bacon's heart and sent him down to posterity a dishonored name.

But in spite of the fact that Bacon is only known by his system of induction, which, by the way, is fundamentally different from the Aristotelian ἐπαγωγή in that it has discovery and not demonstration for its end, and definitely provides for working hypotheses which may either run counter to ἐπιστήμη or for a time prove mutually irreconcilable—in spite of this fact, there appear here and there throughout the records of his life evidences that he had always in mind the practical side of his problem, and contemplated the establishment of a great college of research independent of the universities, as the goal of his endeavor. It was probably this end, requiring enormous financial resources for its achievement, that made him so avid of money that posterity has stigmatized him as avaricious.

We fortunately have Bacon's own memoranda of his plan of organization for this new college (Spedding IV, pp. 25, 26). These rough notes were made in July, 1608. The real purpose and intent of the proposed foundation are involved in a phrasing whose significance we quite miss because its Elizabethan words have changed their meanings since Bacon's time. "Invention," for instance, in the 16th century means "research," or "discovery," and an "inventor" is a discoverer of new knowledge (see New English Dictionary, 1); the restricted modern sense of "inventor" is expressed in Elizabethan English by "engineer." The draft for the College of Research that was to build the New Philosophy into a scientific working organization runs as follows:

> The foundation of a College for Inventors. . . . Galeries with statuas for Inventors past and spaces or bases for Inventors to come. And a Library and Inginary.
>
> The Order and Discipline to be mixt with some poynts popular to invite many to contribute and joine.
>
> The rules and prescripts of their studyes and inquyries.
>
> Allowance for travailing; allowance for experiments; Intelligence and Correspondence with Universities abroad.
>
> The manner and Prescripts touching Secrecy, Tradition, and Publication.
>
> Removes and Expulsions in case within a tyme some Invention worthy be not produced and likewise the honors and rewards for Inventors.
>
> Vaults, furnaces, Tarraces for insulation, woork houses of all sorts.

Translated into modern English this gives us the following scheme:

(a) The foundation of a college of research with (1) a hall of fame for statues of those who have contributed to the advancement of science in the past, and (2) bases for statues of those to come, together with (3) adequate library and laboratory facilities.

(b) The plan of organization must contain attractive features to induce public-spirited benefactors to contribute to the support of the college, and scientific men to join its fraternity.

(c) Rules and regulations for the conduct of studies and investigations.

(d) Allowances for travelling expenses; allowances for experiments; allowances for correspondence and communication with foreign universities.

(e) Methods of and regulations for recording such conclusions as are to be kept in cipher until the time is ripe for their publication; for imparting instruction to new-comers; and for the publication of such discoveries as are to be given to the world.

(f) Regulations for removing members who produce no valuable discoveries, and for honoring and rewarding those who do.

(g) Vaults, furnaces, platforms for exposing things to the action of the sun, work-shops of all kinds.

The outstanding feature of this project for a college of research is its startlingly practical character. With the exception of its fifth provision of secrecy and restricted publication,[4] which the subsequent progress

[4] It was an endeavor to determine the scientific significance of his Bi-Literal cipher to which Bacon gives so much space in the *de Augmentis*, that led the writer of this paper first to organize the material here presented—and he is especially indebted to Colonel George Fabyan for free access to the magnificent library of Bacon's work and Baconiana assembled at Riverbank. This library, besides containing one of the very rare copies of Bacon's "de Augmentis," 1623, is unusually rich in materials relating to cryptography and Rosicrucianism. Out of the latter movement developed the earliest ascription of Shakspere's Works to Francis Bacon. Bacon divides research into *Inventio* (*i.e.*, discovery), *Memoria* (*i.e.*, record) and *Traditio* (*i.e.*, handing down to posterity). His *Traditio* is to be selective; for he clearly realizes that the New Philosophy will yield new principles of science which

of science has rendered supererogatory, Bacon's program might well be adopted *in toto* by modern foundations for research.

Its controlling idea is service—"proficience"—and its end the "advancement" of science through successive discoveries; moreover it mechanically excludes from "research" all those multifarious varieties of compilatory investigation (what Zupitza used to call *reine belesenheit*) which so clog our modern research endowments.

That Bacon's project was no mere passing display of intellectual acumen—in his own words, a "matter of strangeness without worthyness"—is at once evident when we turn to the *Atlantis* and read this fragment in the light of the provisions outlined above.

Scattered through Bacon's writings here and there are references to the "House of Wisdom," or its Latin equivalent *Aedes Salomonis*. This was his name for his projected college. We have seen Archbishop Tenison definitely employing it with this significance. That it was familiar to the two generations following Bacon is evident in the writings of the 17th century century Rosicrucians, whose organization was an offshoot of the New Philosophy and made the *Atlantis* a part of its constitution.

*The New Atlantis* was first published by Rawley, Bacon's secretary-chaplain, in the year after Bacon's death. From Rawley's description of the fragment it is evident that Bacon intended it to be the introduction to an imaginary picture of his college of research in practical operation to make organized knowledge "proficient" to the regeneration of human society—the *Aedes Salomonis operans*.

We have not time here to describe this book, beyond pointing out the fact that it is *not* the weak imitation of the *Utopia* that our proneness to compute antiquity backwards makes it appear.

Bacon's project, however, was not destined to bear fruit in the way its author planned. It has never been actually realized. But in the inscrutable providence of science it was destined to fructify centuries later in the activities of organizations like that which brings us together this afternoon.

About fifteen years after Bacon's death a group of "divers worthy persons inquisitive into Natural Philosophy and other parts of Humane Learning, and particularly what has been called the New Philosophy" . . . began "by agreement to meet weekly in London to treat and discourse of such affairs."

One of these enthusiasts was Dr. John Wallis, later Savilian professor of astronomy in Oxford. Wallis was especially interested in the scientific study of philology, and in 1653 published his *Grammatica Linguae Anglicanae,* still one of our most valuable sources for an accurate knowledge of seventeenth-century English phonology. The sub-title of this work is significant — *Tractatus Grammatico-Physicus* — clearly recognizing as it does the fact that the phenomena of speech are subject to physical laws.

It is Wallis who has preserved for us the interesting record of the proceedings of this infant scientific society from which we are quoting.[5]

The weekly meetings were often held, Wallis says, at Mr. Goddard's lodgings in Wood Street, because Goddard employed a man to grind glasses for telescopes and microscopes, then becoming useful tools for scientific investigation. The business of the meetings, we are told, precluded theology and politics, and was devoted solely to the scientific discussion of such topics as "the circulation of the blood," "the lymphatic vessels," "the Copernican hypothesis," "the satellites of Jupiter," "the spots in the sun," "the improvement of telescopes," "the weight of air," "the possibility or impossibility of vacuities," "the descent of heavy bodies and the degrees of acceleration therein"—"with other things pertaining to the new philosophy."

The hypotheses indicated by these titles are the foundation stones of our modern scientific research. Some of them were laid by the original members of the new society; others were new points of view which the world was still prejudiced against and "with loud clamor hooted their projectors."

> About the year 1648 some of our company being removed to Oxford . . . those in London continued to meet there as before; . . . and those of us in Oxford . . . continued such meetings in Oxford and brought those studies into fashion there.
>
> After the King's return in 1660, the London meetings were increased with the accession of diver's worthy and Honorable Persons; and were afterwards [the exact date is 15 July, 1662] incorporated by the name of the *Royal Society &c.* ["for the improving of Natural Knowledge by Experiments," as the charter completely styles the new organization] and so continue to this day.

The first proceedings were published in March, 1664, under the title "Philosophical Transactions," with the distinct *caveat* that the society was not responsible for the views expressed by its members.

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may contradict received truth, and for the good of society these discoveries must be held back until such time as the world can bear their light, by recording them in a cipher (probably the Bi-Literal), the key to which is to be transmitted to posterity through a line of trusted heads of the college who are in the secret.

[5] It appears among certain autobiographic notes which in the form of a letter to Dr. Thomas Smith are included in Appendix XI to the preface of Hearne's edition of "Peter Langtoft's Chronicle" (1725). The passage relating to the Royal Society is also found in the later editions of Wallis's "Grammatica."

The first volume of these transactions makes interesting reading to-day. It shows that one of the most active pioneer members, besides the philologist, John Wallis, was Mr. Robert Boyle, who in his letters refers to himself as also a member of the "invisible college," probably the Rosicrucian offshoot of the New Philosophy, composed originally of scientific men bound together as an esoteric sodality without name or meeting place and having for its sole end the alleviation of the physical and spiritual ills of humanity.

It seems that at first Sir Isaac Newton held somewhat aloof from the infant Royal Society. They appear, however, to have felt that they could not get along without him, and in January, 1671 (O. S.), he was elected a fellow and accepted the honor.

But difficulties soon arose with the secretary, Oldenburg, in connection, apparently, with some disposition to criticize Newton's new theory of light. On the 8th of March, 1673, Sir Isaac writes a tart note to the secretary saying that he desires "to be put out from being any longer fellow of the Royal Society" on the ground that "the connection is not profitable to either party."

The society then offered to excuse him from paying his dues, a proffer which Sir Isaac, in his reply to the letter announcing the action, affects to consider immaterial.

In 1675 the matter seems to have been satisfactorily adjusted and Newton is reenrolled as a fellow. But evidently peace did not last long, and the controversy over his theory of light did not subside; for in 1676 he writes to the secretary saying that 'he will resolutely bid adieu to philosophy eternally, excepting what he does for his private satisfaction or leaves for publication after his death; for he sees that a man must either resolve to publish nothing new, or spend his whole life in defending his hypothesis.'

Fortunately for the world, he later revoked his decision and from 1703 to his death was president of the organization which published his *Principia*.

I have dwelt on these excerpts from the early minutes of the Royal Society because they are so eloquent of the personal equations involved in bringing scientific men together for what Bacon calls "intelligence mutual, contract, fraternity, and conjunction of labors."

The subsequent history of the Royal Society and later similar organizations like our own is in large part the history of the "proficience and advancement of learning," and I hope our brief computation of antiquity forwards will have made evident that in one sense we are this afternoon really celebrating the 300th birthday of the "able and sufficient" parent of the American Association for the Advancement of Science.

PURDUE UNIVERSITY MARK H. LIDDELL

## THE TERMINOLOGY OF CERTAIN PHYSICAL AND BIOLOGICAL EFFECTS OF LIGHT

IN any discussion of the nomenclature of matters pertaining to light one must first make clear what he means by the term light. For there are several definitions extant in illuminating engineering and other literature. In the present case I shall define light as electromagnetic radiation of such wavelength that it may effect adequate stimulation of the sense of sight.[1] Or, light is photic radiation, where photic means effective in producing the sensation of brightness contrast. In this definition light has an objective reality, as all measurable things in physics have. To bring out clearly what the present usage[2] of the term radiation is and how the above definition of light is related thereto I am giving the chart of Fig. 1.

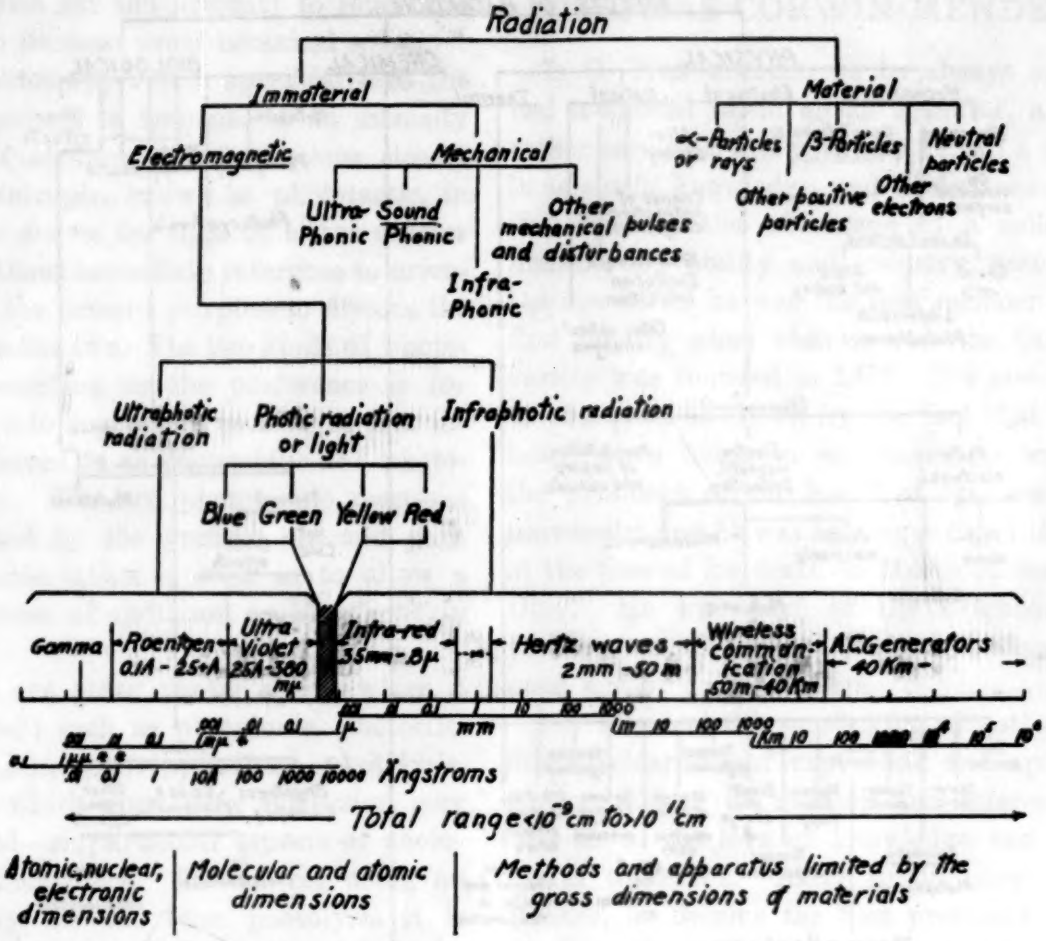
When one surveys the effects of light he finds that there is a considerable confusion of terminology, leading in some cases to an actual confusion of the phenomena. This results in some instances from a lack of short connotative words. The purpose of this note is to point out how a few of these shortcomings in nomenclature may be rectified. For example, the term phototropy has a meaning in zoology different from that in physics. In fact, this word has two different meanings in each of these two sciences. The word photolysis has had a meaning in botany different from that in chemistry.

To make certain suggestions regarding this matter clear and yet succinct, the chart of Fig. 2 is given. Here the various effects of radiation are enumerated and the effects of light are there also as effects of radiation of particular wavelengths. The gross classification into the physical, the chemical and the biological is conventional, having practical but no logical significance. When more shall have been learned about the effects, a better classification no doubt may be had by ignoring this convention. It must be obvious to every one that such a classification has always fringes where the subject-matter may not be clearly demarcated. Some effects are indicated under more than one class, and many others might have been or will be probably as data are accumulated.

The first items for consideration as new suggestions are the terms describing the electrical effects. The phenomenon referred to sometimes as the electromotive force due to light I have termed photovoltic. Certain substances like silver sulphide will, when made a part of a metal circuit, exhibit a difference of potential between illuminated and unilluminated

[1] For other definitions of light see Trans. I. E. S. 1918 and 1922. For a discussion of the definition given above see J. Fr. Inst., 1923.

[2] This matter will be discussed in greater detail in another paper.




* Frequently, especially in older literature μμ

** Sometimes ψμ, recently.

FIG. 1 Chart showing what the concept radiation implies and how the concept light is related to it

portions. Many solutions into which electrodes are immersed will do this, notably cuprous oxide in saline solutions, when one electrode is illuminated. The term photovoltic has obvious advantages over other more lengthy phrases or terms. It will not be confused with the word photovoltaic that has been used (but very infrequently) to denote a change of resistance of selenium when illuminated. For this last effect the term photohmic is reserved. In these two cases at least we find that the use of the name of the unit of resistance and of the unit of potential results in short euphonic and connotative words; and one is inclined to press this method of word formation to other cases. For instance, a change in inductive capacity due to light may be referred to as a photohenric effect. Here we may actually avoid a possible confusion with the phenomenon of the induction period in photochemistry, although the term may not pass as euphonic as the two above.

The ordinary Hallwacks effect (emission of electrons from illuminated metals) is usually called the photoelectric effect, although it might more appropriately be called the photoelectronic effect. Yet the term photoelectric having been so commonly used will cause no confusion if it be allowed that the term photoelectrical have a more general meaning, as indicated in the chart. Certainly, a term of quite general meaning is desirable here. Other effects named in the chart as photoelectrical are self-explanatory; such as photoionic (*e.g.*, in gases), and magnetic induction. The latter refers to such effects as are taken advantage of in radio communication and do not interest us from the standpoint of light. The precipitation of colloids by light is due to the formation of charged particles so that one may wish to insert it elsewhere.

For completeness the photo-magnetic effects now appearing in the literature should be inserted under the electrical group.

Under the optical effects photallochromy is suggested as a substitute for phototropy. What has actually been classified as phototropic heretofore are effects due to light which change the physical state of a body such as to cause the body to appear of different color. Now a body may be changed physically without a change of color, and there are other ways in which such changes may be detected. The allotropic changes and color changes may have no relation to each other and the nomenclature should differentiate between the two sets of effects. Examples of allotropic changes due to light are the change of yellow into red phosphorus, oxygen into ozone, soluble into insoluble sulphur.

To take cognizance of the color changes which

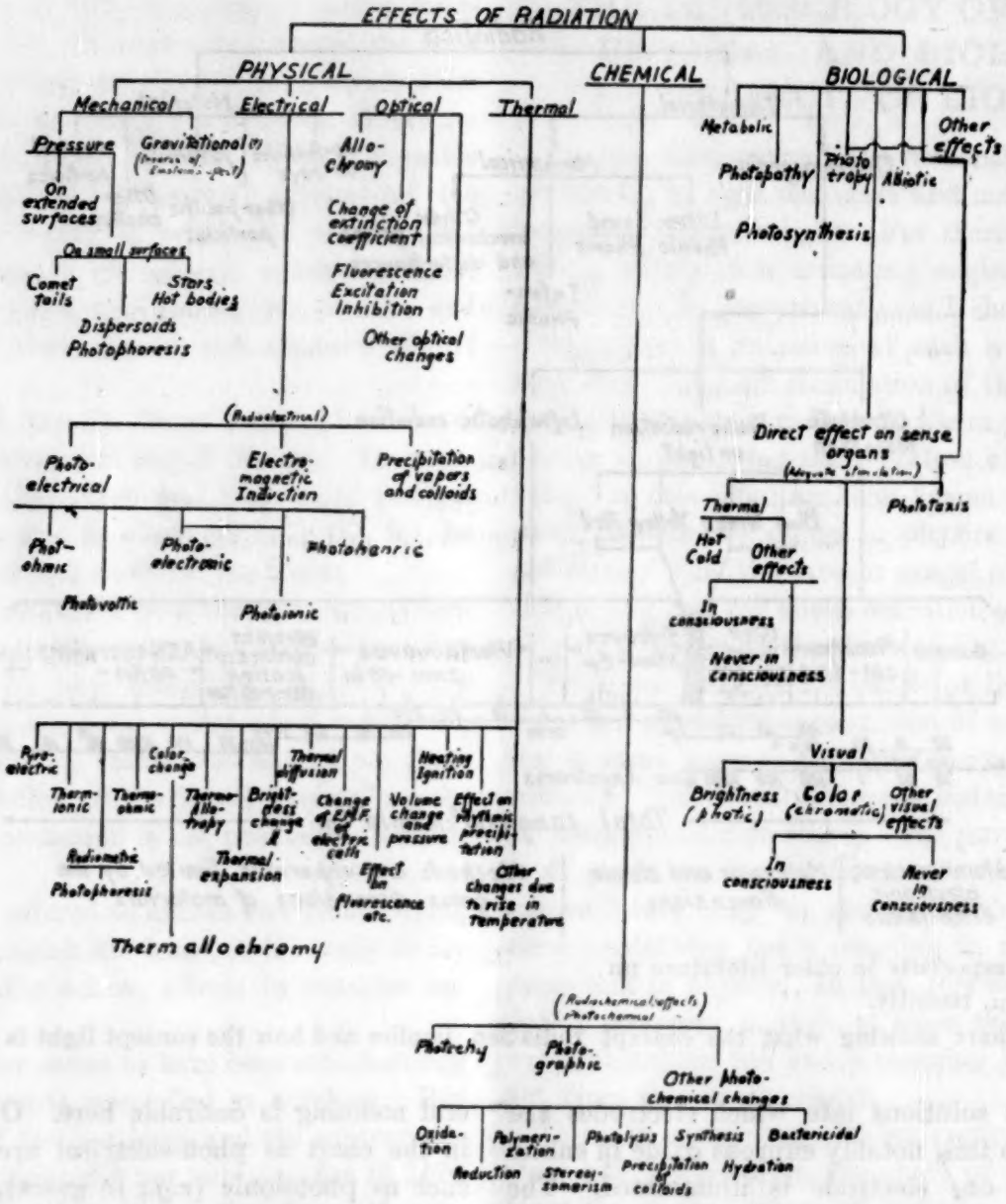



FIG. 2. Chart of effects of radiation

bodies and substances undergo when subjected to different environments the term allochromy is suggested. Accordingly photallochromy (as in phosphorus) is under optical, while thermallochromy (mercuric iodide) lies under thermal effects. Incidentally, this term lends itself well to all such other changes of color as are caused by crushing (piezzallochromy), and even by chemical reactions (chemallochromy) or those brought about in organisms (bioallochromy). Photallochromy has recently received considerable attention in connection with the lighting of museums, where the fading of specimens due to light is a serious matter.[3] The general phenomenon of allotropic changes due to radiation is placed under chemical effects.

Most of the new terms under thermal effects will now also be clear. Instead of the term pyroelectric the term pyrovoltic may be used in accordance with the terms suggested and discussed under electrical effects.

Under the chemical effects no suggestions are offered. For a most excellent detailed classification here reference may be made to Plotnikow in his "Lehrbuch der Photochemie."

Certain points for discussion arise in connection with the biological group. The word phototropy may be retained here since it has been entirely deleted from the physical and chemical groups. Yet with its duplicity of meaning in zoology it might be questioned whether or not it is retainable with clarity to designate one specific phenomenon as the botanists have it, and whether it had not rather be relegated to the indefinite and popular usage where its various meanings may be retained without serious consequences. Botanists and zoologists recognize a large number of reactions known as tropism. These are described by various affixes as rheo, geo, photo, rheostich,[4] chemo and others. It may be convenient

[3] Ill. Engr. (London) 15, p. 308, 1923.

[4] The word rheostichotropism (stream, line, adjustment) was coined to designate the structural adjustment in organism toward streamline contours. See Jour. Franklin Inst. p. 737, 1923. Inadvertently the middle root was deleted in the galley proof and the word ap-

herefore (and I wish for the present) to retain the ord phototropy in its most usual botanical sense.

In this sense phototropy refers specifically to the rientation by organisms in response to an intensity radient. There is another set of reactions closely elated to the phototropic, known as phototactic, in hich preference is shown for light of either greater r less intensity without immediate reference to orien- ation. It is aside the present purpose to discuss the elationship between the two. The two kinds of photo- actic reactions, according as the preference is for nd the movement into regions of greater or less in- ensity, may be referred to as photophilic and photo- hobic, respectively. The two phototropic reactions ay be distinguished by the prefixes dia and para ccording as the orientation is such as to allow a aximum or minimum of radiation to be *effectively* bsorbed.

In botany there are other photic effects which I ave not enumerated; such as phototonic, photoclis- ogamic, photoauxesis, photoperiodism, photolysis, nd certain others which upon close inspection may ossibly be classified—as particular aspects of photo- ropism or some other effect. These bring along no nconsistencies—only for the term photolysis it is uggested that the meaning given by the chemist be he recognized one (*viz.*, dissolution or solution of ells or substances).

I am suggesting the use of the term photopathy in rather general sense and with a connotation that is uggested by the root *pathos* when used in such a ord as pathology. Photopathy then includes such ffects as photomania, photalgia, photerythema, pho- oncia (swelling), photoptarmosis (sneezing). An ndependent position should perhaps be given in the hart to photomorphosis or photomorphism for the tructural effects in organisms due to light.

Through this note I hope that an impetus may have been given to those who are interested in the various effects of radiation, and of light—photochemical, photophysical and photobiological—to give some at- tention to certain matters of nomenclature that may result in clarity and unity of usage in the widely separated branches of science. It is hardly to be ex- pected that my first suggestions given above on such matters of nomenclature will be equally satisfactory to the botanist, the zoologist, the chemist and the physicist, and shall we say, the pathologist or the phototherapist.

DR. ENOCH KARRER

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pears as rheotropism which has already a well established meaning in zoology different from that intended here. A more desirable word it now seems to me is *rheo- morphism.*

## THOMAS CORWIN MENDENHALL

T. C. MENDENHALL, as he always signed himself, had a special talent as an educator, a valuable and rather rare gift, and with this he had a strong interest in scientific knowledge, and tireless energy in seeking it. Without the advantage of a college education himself, his ability and industry were such that at the age of 32 he was the first member elected to the first faculty when what is now the Ohio State University was founded in 1873. His steadfast devotion to education is shown by the fact that just 50 years later, when living in retirement, he was selected as the president of the board of trustees of this same university, and he was serving actively in this capacity at the time of his death on March 22 last at Ravenna, Ohio. He was born in the neighboring town of Hanoverton, October 4, 1841, and thus lived to the good age of over 82 years.

Dr. Mendenhall's success in educational work was due to clearness of expression and aptness of illustration, charm of manner and interest in men, as well as in his love of knowledge and of making it useful to others. After preliminary training as a teacher, he became the first professor of physics in the Ohio State University, and served in this capacity for five years. At this time scientific education in the United States was in an early stage and Dr. Mendenhall exerted an important influence in its development in the middle west. He refers to the period as one "when those engaged in scientific research even for a very small portion of their time were but a handful." An associate of those days writes "he was full to overflowing with the purpose to do his share in giving to science study its deserved place in public schools and placing it upon the proper plane in colleges." When Japan determined to develop a great university at Tokyo she called for help from England and America, and Professor Mendenhall was one of a group of able men invited. He went to Japan in 1878 as professor of physics in the Imperial University, and remained three years. He then returned to the Ohio University. Later, after service with the government, he was president for several years of the then recently organized Rose Polytechnic Institute, and again after another term of public duty, he was president for seven years of the Worcester Polytechnic Institute, from which he retired in 1901. Thus in the educational field he organized the departments of physics in two universities, was president of two engineering colleges, and closed his career as a trustee of his state university. His students remember his clear exposition, his kindly interest and his helpful practical advice; his stimulating influence affected the future of many men. When Dr. Mendenhall retired from the Rose

Polytechnic Institute in 1889, the student body united in a tribute of affection and appreciation.

Although he commenced and closed his career in educational work, three times returning to it, Dr. Mendenhall's life was filled also with other activities having to do with science and engineering, in which he showed his ability for organization and administration, and his interest in science and its application. He was for five years Superintendent of the Coast and Geodetic Survey, and a mere list of his other assignments shows the range and extent of his activities over a number of years. He was a professor in the U. S. Signal Corps for several years engaged in investigations of atmospheric electricity, a member of the Lighthouse Board, a member of the first Bering Sea Commission, a member of the United States and Canadian Boundary Commission, a member of the Massachusetts Highway Commission, a United States delegate to the International Electrical Congress in 1893, president of the American Association for the Advancement of Science, president of the American Metrological Society, Superintendent of the Office of Weights and Measures, first chairman of the U. S. Geographic Board, vice-president of the Cosmos Club, the Scientific Club of Washington, and a member of the National Academy of Sciences and of many other organizations. This list illustrates his willingness to serve the public, and his active participation and fellowship in the organized efforts of scientific men. He left Washington thirty years ago, after some very active years, and those who knew him in those days remember his many-sided interest in scientific endeavor, and particularly his clear and pleasing addresses, always making his subject entertaining by apt illustration. During one period Dr. Mendenhall's courage in following high ideals of public service was shown by the sacrifice of his own interests and comfort in resisting demoralizing small politics in government administration; subsequent events confirmed the correctness of his course.

While connected with the University of Tokyo, Professor Mendenhall made a measurement of the absolute force of gravity at Tokyo, and later, in 1880, measured the relative force of gravity between Tokyo and the summit of Fujiyama by swinging an invariable pendulum at the two places, and from this made a computation of the mean density of the earth. While more precise determinations of this constant have been obtained by other methods, this measurement was the best of its kind. Some years later, when Superintendent of the Coast and Geodetic Survey, he was mainly responsible for the development of an improved portable apparatus for the measurement of the relative force of gravity by means of half second pendulums, which apparatus greatly increased the accuracy and facility of such determinations, and he planned the first extensive use of the apparatus in a transcontinental series of gravity measurements in 1894, and arranged for the cooperation of an eminent geologist in this work. It is substantially this apparatus which has been employed in the investigation of the condition of the earth's crust made in this country and elsewhere in the years since. He first proposed the use of a ring pendulum for the absolute measurement of the value of the acceleration of gravity, a method which, besides being of scientific value, is used in college laboratories.

Dr. Mendenhall was one of the American delegates to the International Electrical Congress in 1893, and took an active part in that gathering of eminent physicists from various countries, which resulted in the adoption of definitions for the electrical units; the original draft of these definitions, in his handwriting, is in the archives of the Franklin Institute.

In 1885, a few months after its completion, the Washington Monument was struck by lightning and seriously injured. Mendenhall, then in charge of the physical laboratory of the Signal Corps, after investigation in cooperation with Rowland, devised the scheme of protecting the monument from lightning which has been successful.

The versatility of his interest is shown by his study of characteristic word lengths of various writers, and he originated the idea of using curves for this purpose, which curves he showed were distinctive for various authors, but practically constant for one writer.

Dr. Mendenhall was a contributor to scientific periodicals and reports, and published a small volume, "A Century of Electricity." His writings were clear and pleasing. He always sought to popularize science and to bring it to a wider circle, but never to lower its standards or ideals.

For some years he was compelled by ill health to rest in Italy, but with methodic effort and endless patience, he again built up his physique, so that he was able to return to his native state. In his later years of retirement in Ohio, in addition to his renewed connection with the university, he was an active voluntary worker among the children of his town, taking pleasure in instructing them in the rudiments of science.

Dr. Mendenhall received a number of honors and medals, both in this country and in Japan. On the presentation of the medal of the Franklin Institute to him in 1918 in recognition of his labors in physical research, it was said that "he is a typical American in that he found and created his own opportunities and indefatigably always gave the best that was in him to serve his fellows and his country."

GEORGE R. PUTNAM

## SCIENTIFIC EVENTS

### PROGRESS IN PREPARATION OF INTERNATIONAL CRITICAL TABLES

INTERNATIONAL CRITICAL TABLES, organized under e auspices of the International Research Council, is portion of the international scientific program, the sponsibility for which has been assigned to the nited States. The work is in charge of the board trustees and the board of editors, appointed rough joint action of the National Research Coun-, American Chemical Society and American Phys-al Society, with headquarters at the National Re-arch Council, Washington, D. C.

The work of preparing the data for International ritical Tables is now actively under way. The mate-al is being collected and critically evaluated by ap-roximately 300 competent experts distributed among e following countries: United States, Canada, reat Britain, Belgium, France, Italy, Austria, Ger-any, Denmark, Switzerland, Holland, Australia and apan.

The program covers all available information of alue concerning all the properties and numerical haracteristics of (a) pure substances, (b) physico-hemical systems of definite composition, (c) many in-ustrial materials, (d) many natural materials and e) selected data for selected natural bodies or sys-ems, such as the earth and its main physical sub-ivisions, the solar and stellar systems and certain iological organisms, including man. Publications of he world in all languages will be combed for data nd much unpublished information is also being ollected. In addition to the stupendous scope of he tables, hitherto unapproached by any similar pub-ication, the volumes will contain many novel features f arrangement. Thus, for example, not only will it e possible to find readily all the properties of a iven substance or material but it will also be pos-ible in many cases to ascertain readily what sub-tance or material of a given kind has a maximum, minimum or a given value for any given property. his feature will be of great assistance in identifying substance by means of its properties or in select-ng a substance or material on the basis of a given roperty or combination of properties. The main escriptive material and the very complex index to he tables will be in four languages, English, French, German and Italian.

In order to assist the board of editors in connection with the work of the cooperating experts in foreign countries and in the collecting of information from these countries, ten corresponding editors have been appointed. These editors have greatly assisted the board in connection with the selection of competent cooperating experts. They have general charge of relations with the experts in their respective countries and also assist the board in securing data from their own and neighboring countries. Following is a list of these editors and their advisory committees:

THE BRITISH EMPIRE (excluding British North America). Dr. G. W. C. Kaye, National Physical Laboratory, Teddington, England. Advisory committee: Sir Robert Robertson, W. Rosenhain, J. E. Sears, T. E. Stanton, W. F. Higgins, A. W. Porter.

BRITISH NORTH AMERICA. Dr. Otto Maass, department of chemistry, McGill University. Advisory committee: J. W. Bain, R. J. Durley, A. L. Hughes, G. S. Whitby.

JAPAN (and eastern Asia). Professor Kotaro Honda, Iron and Steel Institute, Tohoku University, Sendai, Japan.

BELGIUM (and its dependencies). Professor M. Strauven, Liége, Belgium.

HOLLAND (and its dependencies). Dr. W. J. van Heteron, Utrecht, Holland. Advisory committee: Ernst Cohen, C. A. Crommelin, H. Baucke.

DENMARK (Norway and Sweden). Professor Dr. Niels Bjerrum, Copenhagen, K. Denmark. Advisory committee: Martin Knudsen, Carl Jacobsen.

FRANCE (Spain and Portugal). Dr. Charles Marie, Paris, France. Advisory committee: C. Moureu, A. Fabry, A. Guillet.

SWITZERLAND. Professor A. Berthoud, Neuchâtel, Switzerland. Advisory committee: Ch. E. Guye, H. Rupe, F. Schule.

AUSTRIA (central and southeastern Europe). Professor Dr. Rudolf Wegscheider, Vienna, Austria.

ITALY (and its dependencies). Professor Eicola Parravano, Istituto Chimico, R. Universita, Rome, Italy. Advisory committee: Ugo Bordoni, Luigi Rolla, Francesco Giordani.

### THE NEW ENGINEERING BUILDINGS OF UNIVERSITY COLLEGE

ACCORDING to the London *Times* the new buildings of the faculty of engineering of University College, London, have just been completed, and will be formally opened in the near future.

Professor Simpson has designed the new wing to harmonize with the existing buildings and Professor Coker and his staff, aided by Sir Ernest Moir and Sir Alexander Kennedy, have given much care to the working out of suitable plans. The main engineering laboratory is equipped to show the best practice in heat engines and provision is made for experiment and advanced research; also for experiment in connection with the testing of materials.

For advanced and post-graduate students, in addition to a laboratory there are available a number of small rooms suitable for research work. Other provision includes an additional electrical laboratory, a large lecture room and a laboratory for the department of municipal engineering. In the basement a

considerable area will be available for the Hawksley hydraulic laboratory. There are well-lighted drawing offices for students on the second floor.

One of the most interesting of the rooms is that devoted to the study and measurement of sound, especially in connection with wireless, cables and telephony, over which Professor J. A. Fleming presides. By means of a delicate instrument it is made apparent that the whole of London is vibrating, a fact due, according to Professor Fleming, to the tube railways.

The reconstruction and reequipment of the engineering buildings has so far cost the authorities of the college £53,500, of which £10,000 has been contributed by the London County Council and £10,000 by Lord Cowdray.

Modern work in industrial chemistry is so intimately connected with engineering that it is proposed to erect, with the aid of a grant of £25,000 from the Ramsay memorial fund, a chemical engineering building to house the equipment and lecture-rooms and give other special accommodation required for this purpose. The department has already made a promising start, and is intended to form a connecting link between the schools of chemistry under the direction of Professor Collie, F.R.S., and Professor Donnan, F.R.S., and the engineering school.

## THE SECTION OF PSYCHOLOGY OF THE BRITISH ASSOCIATION

Oversea members of the British Association for the Advancement of Science coming to the Toronto meeting, beginning August 6, include the following:

*President of Section J*—W. McDougall, professor of psychology, Harvard University. Late reader in mental philosophy, Oxford. In his presidential address he will deal with "Purposive action as a fundamental conception in psychology," and will deliver a lecture on "Human heredity and national (or racial) outlook."

*Vice-President*—Cyril Burt, of the department of education, London County Council. Speaks on "Tests for scholarship and promotion."

*Recorder*—L. Wynn-Jones, Harrogate.

*Secretary*—R. J. Bartlett.

*Secretary*—Shepherd Dawson, Glasgow.

F. A. Aveling, reader in psychology, University of London. General secretary of the British Psychological Society. Will speak on the "Standpoint of psychology."

F. C. Bartlett, professor of experimental psychology, Cambridge.

William Brown, Wilde reader in mental philosophy, Oxford.

H. Wildon Carr, professor of philosophy, University of London, editor of proceedings of Aristotelean Society.

J. Drever, reader and lecturer in psychology, University of Edinburgh, will speak on "Psychological theories of laughter."

J. C. Flügel, senior lecturer in philosophy and psychology, University College, London, will discuss "Feeling and emotion in daily life."

B. Hart, physician in psychological medicine and lecturer in psychiatry in University College Hospital Medical School, London.

Dr. J. T. MacCurdy, formerly of Toronto and Cornell, now of Cambridge.

C. S. Myers, director of the National Institute of Industrial Psychology, editor of the *British Journal of Psychology*, presents a paper on the "Conception of fatigue," in the joint discussion between physiology and psychology sections dealing with "Physiological factors of muscular efficiency in industry."

T. H. Pear, professor of psychology in the University of Manchester.

C. E. Spearman, Grote professor of mind and logic, University of London.

## SCHOOL OF HYGIENE IN THE UNIVERSITY OF TORONTO

On May 20, the International Health Board of the Rockefeller Foundation approved of a proposal to assist financially in the creation and endowment of a school of hygiene in the University of Toronto; and the following day the Rockefeller Foundation pledged $650,000 to the governors of the University of Toronto, for this purpose. The governors of the university have accepted the proposals and the above-mentioned sum will be utilized to provide a building to cost not more than $400,000; the remaining $250,000 will be used for the endowment of the school. While final details of organization remain to be perfected, the school will include the departments of hygiene and preventive medicine and public health nursing and the Connaught laboratories. The operating or public-service divisions (namely the antitoxin and insulin) of the Connaught laboratories will be merged and constitute a public service section in the school.

The endowment will be added to by the inclusion of the resources of these laboratories, namely the Connaught laboratories research fund. The governors of the university have agreed to maintain the building and continue to sustain the budgets appropriated for 1924–25, for the maintenance of the teaching departments of hygiene and preventive medicine and public health nursing.

## APPOINTMENTS AT THE ROCKEFELLER INSTITUTE

The board of scientific directors of the Rockefeller Institute for Medical Research announces the election of Dr. Francis Gilman Blake as a member of the board of scientific directors to succeed Dr. Hermann M. Biggs, deceased.

The following promotions and appointments are announced:

Promotions:

*Associate Member to Member:*

Dr. James B. Murphy
Dr. John H. Northrop

*Associate to Associate Member:*

Dr. Thomas M. Rivers

*Fellow to Assistant:*

Miss Gladys Bryant
Dr. Charles Korb
Miss Dorothy Loomis
Dr. Elmer L. Straub

Dr. William S. Tillett has been appointed resident physician at the hospital.

New Appointments:

*Assistants:*

Dr. Douglas Boyd
Dr. Clifford L. Derick
Dr. Louis A. Julianelle
Dr. Ann G. Kuttner
Dr. John F. McIntosh
Mr. Bernard J. C. Vander Hoeven

*Fellow:*

Dr. David Davidson

Dr. Paul E. Howe, hitherto an associate in the department of animal pathology, has accepted an appointment with the division of animal husbandry, Bureau of Animal Industry, U. S. Department of Agriculture, in charge of nutrition investigations.

Dr. George R. Brow, hitherto an assistant in the department of the hospital, has accepted an appointment as research assistant at the University College Hospital, London, under Sir Thomas Lewis.

Dr. Geoffry C. Linder, hitherto an assistant in the department of the hospital, has accepted an appointment at St. Bartholomew's Hospital, London, under Professor Francis R. Fraser.

Dr. Hugh J. Morgan, hitherto an assistant and resident physician at the hospital, has accepted an appointment as associate professor of medicine at Vanderbilt University.

Dr. James M. Neill, hitherto an assistant in the department of the hospital, has accepted an appointment as associate professor of bacteriology at Vanderbilt University.

Dr. Harold A. Salvesen, hitherto an assistant in the department of the hospital, has accepted an appointment as chief of clinic at the Physiologic Institute, University of Christiania, Norway.

## SCIENTIFIC NOTES AND NEWS

DR. ROBERT SIMPSON WOODWARD, president of the Carnegie Institution from 1905 to 1920, and formerly professor of physics in Columbia University, died on June 29, at the age of seventy-five years.

DR. ADRIAAN VAN MAANEN, of Mount Wilson Observatory of the Carnegie Institution, has been elected correspondent of the Royal Academy of Sciences at Amsterdam.

PROFESSOR E. BATAILLON, of the University of Montpellier, has been elected associate of the Royal Academy of Belgium, in succession to the late Dr. Jacques Loeb.

THE University of Chicago has conferred the Rosenberg medal upon Dr. Frederick G. Banting, of Toronto. This medal is awarded annually by the university to the person conferring the greatest benefit upon humanity.

THE Helmholtz gold medal, awarded once in ten years by an international committee for the most significant research in the domain of optics, has been given to Professor K. von Hess, of Münich, for his investigations on color vision.

SIR ERNEST RUTHERFORD has been appointed by the University of Cambridge delegate to the Franklin Institute on the occasion of its centenary next September.

THE University of Colorado at its recent commencement conferred the honorary degree of doctor of science upon Professor William Duane, of Harvard University.

DR. RAY LYMAN WILBUR, president of Leland Stanford University, has received the honorary degree of doctor of science from Syracuse University.

THE University of Aberdeen has conferred upon Sir Henry Gray, head of the surgical division of the Royal Victoria Hospital, Montreal, the honorary degree of LL.D.

DR. ALBERT ERNEST JENKS, professor of anthropology, University of Minnesota, and chairman of the division of anthropology and psychology, National Research Council, delivered an address on "The dawning era of science" at the seventieth annual commencement of Kalamazoo College, June 18, on which occasion the college conferred on him the honorary degree of doctor of science.

A CORRESPONDENT writes that Professor F. X. Schaffer, of the Naturhistorisches Staatsmuseum, Vienna, will arrive in the United States during the summer and will spend the remainder of the year traveling in various parts of the country. He is prepared to give lectures on the more recent interpretations of the Pleistocene of Europe.

PROFESSOR W. A. NOYES, of the California Institute of Technology, has given lectures in England at the Universities of Oxford, London, Cambridge and Manchester and in Germany. He will continue his

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Coleman for the school of medicine. The gift is in the form of a memorial to their daughter and will be used to endow the chairs of ophthalmology, surgery and gynecology.

ANNOUNCEMENT has been made of the gift by the Carnegie Corporation of $20,000, annually for two years, to the University of Louisville medical department, while plans are being perfected for raising an endowment fund. The added income will be used largely in developing the department of pediatrics.

CAMBRIDGE UNIVERSITY receives by the bequest of the late Mrs. Constance Jenkinson £2,216 for the purpose of founding a lectureship for the encouragement and advance of research in comparative and experimental embryology in the university, to be called, in memory of her late husband, the John Wilfred Jenkinson Memorial Lectureship.

DR. CHARLES K. EDMUNDS, for the last fifteen years president of Canton Christian College, China, was installed on July 1 as provost of Johns Hopkins University. Dr. Edmunds is an alumnus of Johns Hopkins and for eleven years was in charge of the Carnegie Institution's magnetic survey of the China coast.

DR. WILLIAM H. S. DEMAREST, president of Rutgers College, has resigned. The dean of the college, Walter T. Marvin, became acting president on July 1.

DR. A. PRINGLE JAMESON has resigned from his position as professor of zoology in Mills College, Oakland, California, and has accepted a lectureship in the University of Cambridge, where he will have charge of investigations on the parasites of domestic animals. Dr. Horace Gunthorp, of the University of Washington, has been appointed as head of the department of zoology at Mills College.

DR. WILLIAM G. SMEATON and Dr. Floyd Bartell have been promoted to full professorships in the department of chemistry, University of Michigan.

DR. SAMUEL C. HARVEY has been appointed professor of surgery at Yale University.

DR. JOHN FAVILL has been appointed clinical professor in the department of medicine at Rush Medical College at the University of Chicago.

AT the University of Minnesota Dr. Karl S. Lashley has been promoted to be professor of psychology.

DR. RICHARD BUETNER, of the University of Leyden, formerly of the Rockefeller Institute, has been appointed assistant professor of pharmacology in the University of Louisville medical department.

DR. EDMUND M. SPIEKER, of the United States Geological Survey, has been appointed assistant professor of geology at Ohio State University.

C. D. HURD, of the University of Illinois, has accepted an assistant professorship in organic chemistry at Northwestern University.

RECENT appointments in the faculty of the University of Arkansas include George C. Fracker, dean of the college of liberal arts of the University of Dubuque, to be professor of psychology and philosophy; Paul A. Cushman, assistant professor in the Brooklyn Polytechnic Institute, to be professor of mechanical engineering; Claud F. Clayton, University of Minnesota, to be associate professor of rural economics.

DR. GLOVER M. ALLEN has resigned as secretary of the Boston Society of Natural History and has been added to the staff of the department of zoology at Harvard University as lecturer on zoology. Dr. Allen will remain librarian of the Boston Society and will also continue his researches on the mammal collections of the Museum of Comparative Zoology.

DR. HARRY SELTZ, instructor at the University of Pennsylvania, has been appointed instructor in physical chemistry at th eCarnegie Institute of Technology in Pittsburgh.

## DISCUSSION AND CORRESPONDENCE

### THE FOSSIL ELEPHANTS OF MINNESOTA

DURING the last year and a half several very remarkable finds of elephant remains have been made within the state of Minnesota. These consist of parts of the skeleton in almost perfect preservation. The first was discovered while making an excavation for the abutment of a bridge over a new dredge ditch that drains the area south of Blue Earth River, eight miles southeast of the town of Blue Earth, and four miles west of Frost. This area is an old post-glacial lake bed, according to Dr. George A. Thiel, who superintended the removal of the bones, and in which no drift was cut by the ditch. The bones were in clay and sandy layers seven to ten feet below the surface, the upper four or five feet of which pass into a black soil. The skeleton was apparently somewhat scattered as originally deposited, for only a few vertebrae, a half dozen ribs, a radius, the head of a humerus and of a femur, three tarsal bones and various other fragments were recovered. But these are sufficient to show the size of the animal and for its identification, since a comparison of them with the next specimen indicates that they came from an animal similar in every respect.

The second of these recent finds is the best and most complete specimen so far found in the state. It came from Mr. P. D. McMillan's farm in the eastern part of Freeborn County and was found in the superficial deposits of the area which was formerly Rice

Lake. Some years ago this was a swamp and shallow lake area. Here and there wooded knolls and knobs thirty to forty feet above the general level were islands in the old lake. The filling ranges from a fine gravel to sand and clay with a thick muck soil at the top. Within the last few years a large ditch has been dug through this area and it is now completely drained and bids fair to be one of the finest farming sections of the state. Last spring (1923), when the ditch was being widened and deepened, the dredge threw out parts of the skeleton of a mammoth. These attracted the attention of Mr. McMillan, who brought the upper jaw to the University of Minnesota. Further search was then instituted and this resulted in the recovery of about one fourth of the skeleton. The specimen was found in a stiff blue clay about fifteen feet below the surface with no drift above it. Apparently the skeleton was lying crosswise with the ditch, the tusks being out under the bank. It seems that it had not been disturbed since it sank into the soft muds of the lake and probably the balance of the skeleton is still in place. The portions recovered consist of the upper jaw with an excellent pair of teeth, fragments of the pelvis, one femur, two tibias, tarsals, meta-tarsals, phalanges, one humerus, the larger part of one ulna, various fragmentary ribs, fragments of the cranium and tusk sheaths, vertebrae from the neck, back and tail. Measurements of certain of the skeletal elements indicate an animal about eleven feet high, and the teeth exhibit the usual formula for *Elephas columbi* with seven to seven and one half lamellae to one hundred millimeters.

Most of the previous finds have been of the teeth only and these have been so associated with the drift that it was impossible to determine whether they belonged to the glacial or the post-glacial period. These recent finds seem to indicate that the Columbian elephant survived the glacier in Minnesota and that perhaps we may hope to make other even more important finds as the great muskegs and swamp areas of northern Minnesota are drained.

The following is a list of the elephant remains so far known to have been found within the state:

(1) *Elephas columbi*, a tooth from Rock County, Minnesota.

(2) *Elephas columbi* (?), fragments of vertebrae from Kenyon, Goodhue County, Minnesota.

(3) *Elephas columbi* (?), part of the pelvis found in river gravels eight feet below the surface at Red Wing, Goodhue County, Minnesota.

(4) *Elephas columbi*, a tooth from the river gravels near Red Wing, Goodhue County, Minnesota.

(5) *Mastodon americanus* (?), a vertebra "found in a bed of coarse gravel eight feet below the surface," at Owatonna, Steele County, Minnesota.

(6) *Elephas columbi* (?), a large piece of bone from the drift at Brainerd, Crow Wing County, Minnesota.

(7) *Elephas columbi* (?), a part of a femur labeled an "elephant leg bone from the drift at the site of the M. & St. L. roundhouse, Cedar Lake," Minneapolis, Hennepin County, Minnesota.

(8) *Elephas columbi*, a tooth from Hastings, Dakota County, Minnesota.

(9) *Elephas columbi*, a tooth dredged from the Mississippi River at St. Paul, Minnesota.

(10) *Elephas columbi*, portions of a skeleton from post-glacial lake beds, four miles west of Frost, Faribault County, Minnesota.

(11) *Elephas columbi*, about a fourth of the skeleton, including the upper jaw and teeth, from post-glacial lake beds sixteen miles northeast of Albert Lea, Freeborn County, Minnesota.

(12) *Elephas columbi* (?), base of the skull, showing the occipital condyles, from the drift thirty feet below the surface at Russell, Lyon County, Minnesota.

(13) *Elephas columbi* (?), a tusk, originally four feet long, from the glacial gravels thirty feet below the surface at Farmington, Dakota County, Minnesota.

(14) *Mastodon americanus* (?), a tusk from the superficial deposits (glacial?) at Stillwater, Washington County, Minnesota.

The remains of Pleistocene mammals and of those that immediately succeeded that period are frequently found in the gravels, peat bogs and old lake beds of Minnesota. Among these the Columbian elephant is probably the most common, but no very great attempt has been made to collect those picked up from time to time nor to make a record of the finds as they are reported. But from the number that come in to the university by this casual manner it would seem they must be abundant.

CLINTON R. STAUFFER
UNIVERSITY OF MINNESOTA

## IS THERE AN ENTOMOGENOUS FUNGUS ATTACKING THE CITRUS RUST MITE IN FLORIDA?

IT has been observed annually since 1912 that the citrus rust mite (*Phyllocoptus oleivorus* Ashm.) reaches the point of maximum infestation some time just after the beginning of the rainy season. This is usually the last of June or very early in July. At this time they are usually present in countless numbers. In some instances a single grapefruit may be infested with more than a half million mites. Shortly after the point of maximum infestation is reached the mites disappear as if by magic, so that by the middle or end of September it is nearly impossible to find a single mite present. In some cases more than an hour of diligent search is required to find a single specimen.

There is considerable evidence to show that this disappearance of the citrus rust mite is due to a fungus disease. In many instances the mites congregate on a small area of the fruit which is in the most

direct sunlight. When so herded together, the area occupied by them becomes yellow and it is impossible to see the rind of the fruit at all. The mites in this mass seem to be stuck to each other like numerous angle worms. They are a writhing, wriggling mass and crawl around without any apparent object or direction. Shortly after this congregating the dead bodies of the mites are observed. They occupy the same spot in the direct sunlight as they did before death. The dead bodies take on a more brownish color than when alive. This congregating habit is contrary to the normal habits of the species. Normally this species seek semi-sunshine or partial shadows and are not found in great abundance on the part of the fruit in direct sunlight. This abnormal habit of congregating has been observed many times since 1920.

It has also been observed that most of the adult mites change color from a lemon yellow to a darker or orange yellow. They also become somewhat sluggish in their movements.

An examination of the dead mites usually shows that certain fungal filaments protrude from their bodies. In most instances, also, there are fungus bodies on the inside of the dead mites. In fact, these bodies have been observed in mites which were still alive but which had changed color and become sluggish in their movements. The presence of these fungus bodies in the living mites indicate that the time is approaching when the species will disappear.

There is an enormous amount of data on file in the Bureau of Entomology which proves beyond the possibility of a doubt that the rust mites always become much more abundant following the use of copper sprays or compounds than they do on unsprayed trees and fruit. They are also abundant a considerable length of time after the beginning of the rainy season when scarcely any mites are present on trees not sprayed with copper sprays. The use of such fungicides evidently eliminates the fungus disease which in all probability under normal conditions would have attacked the rust mites. It seems, according to the circumstantial evidence already obtained, that it is reasonably certain that an entomogenous fungus attacks rust mites in Florida. In all probability this same disease attacks the species wherever the climatic conditions permit.

A. T. SPEARE,
W. W. YOTHERS

BUREAU OF ENTOMOLOGY,
U. S. DEPARTMENT OF AGRICULTURE

## PREVENTION OF WEAK LEGS IN EXPERIMENTAL CHICKENS

A DISCUSSION by J. S. Hughes appearing in SCIENCE, February 29, 1924, stated that young chicks often could not be successfully raised in confinement for experimental purposes. He attributes failure to the fact that rickets or "weak legs" develop, due, he thinks, to the absence of direct sunlight. His remedy is to expose the chickens for a few hours each day to sunlight which is not filtered through glass, or to include in their diet cod liver oil, which he has found will prevent the disease.

At present, April 1, 1924, we have in the laboratory 21 chickens which were hatched November 12, 1923. When three days old they were placed in small cages which had been previously sterilized. From that time on they were given no food, grit, water or litter that had not been sterilized. The room in which they were kept was not particularly sunny, and never at any time were they exposed to sunlight that was not filtered through glass windows. Their food consisted chiefly of buttermilk mash, which was always available. When about eight weeks old small amounts of bone meal were mixed with the mash, and raw potatoes were fed to them about twice a week from that time on, the outside of the potatoes being sterilized by immersing them in boiling water. A few carrots were similarly treated, but other than that no vegetables were given. A mixture of fine grains and an abundance of crushed oyster shell and grit composed the remainder of the diet, with the exception of a few dozen hard-boiled eggs, which were fed during the first three months.

None of this lot of chickens has shown any tendency towards the development of "weak legs," although at no time exposed to unfiltered sunlight or furnished cod liver oil. Only a small amount of hard-boiled egg was fed at any time, but the normal development of these chickens may have been to a large extent due to this ingredient in their diet.

JANE COLLIER

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## PERMANENT PHOTOGRAPHS

PROFESSOR PEIRCE'S letter in SCIENCE for April 4 (LIX, No. 1527, pp. 318–319) and Dr. Howard's letter for May 9 (LIX, No. 1532, pp. 422–423) have recalled to the writer's mind an experience, the results of which are of interest to any one making a collection of photographs in which the first requirement is permanency of the photographs collected.

In August, 1915, the writer moved from Palo Alto, Calif., to Ithaca, New York. Boxes of freight containing his books, instruments and miscellaneous collection of photographs were routed east by way of Galveston and New York City. At Galveston they were caught on the wharf by the hurricane of August

19 and were soaked in seawater. They were then carefully forwarded to Ithaca where they were stored in a freight shed until November when the writer arrived in Ithaca. On opening, they were found to have dried out, but all metal objects were crusted with rust, books were black with mould and the photographs were reduced to mouldy cards, on which the emulsion surface was changed to a chalky deposit that showed no traces of the former image; *except* a few *platinotypes,* which survived the whole exposure. These were soaked off of their card backs and, except for some slight moulding, were as perfect as when they were first made. It was a revelation as to what kind of a photograph was really permanent.

The platinotype is a gray or black and white print that was much in vogue thirty years ago. A metallic film is deposited directly on the paper of the print so there is nothing organic to change except the paper itself. The print is as permanent as the paper. It is more difficult to print and is more expensive than the present emulsion prints, but for a collection of portraits such as Professor Peirce and Dr. Howard describe, it makes prints every bit as permanent as engravings and etchings.

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## SCIENTIFIC BOOKS

*Investigations on the Red River made in connection with the Oklahoma-Texas Boundary Suit.* By E. H. SELLARDS, B. C. THARP and R. T. HILL. 8vo., 174 pp., 9 plates, 7 maps in color. University of Texas Bulletin No. 2327. 1923.

THE state of Texas has signalized its victory in the famous Red River boundary dispute by issuing a bulletin of the scientific investigations on which the decision was won. In 1890 the Supreme Court of the United States interpreted the treaty of 1819 between the United States and Spain in such a manner as to fix the south bank of the river as the boundary line. The discovery of oil at Burkburnett in 1918 and in the river valley in 1919 rendered it necessary to determine what constituted the south bank, where the definite boundary should be drawn and whether this line had been affected by changes in the course of the river during the lapse of a century. Suit was accordingly brought by the state of Oklahoma, with the United States as intervener, against the state of Texas for the purpose of locating the exact boundary and settling the title to the valuable oil lands in the "Big Bend" of the river. The main contention of the plaintiff was to the effect that at the time of the treaty with Spain the river in this region flowed at or near the foot of the Texas bluff. On the other hand, the defendant maintained that neither the channel nor the bordering sand stretch lay adjacent to this bluff in the Big Bend area during the past hundred years. As a corollary, Oklahoma contended that the valley had been developed by a process described as "island building" and that all trees more than a hundred years old had originated on such islands, while Texas maintained that the development had followed the normal process of erosion and accretion and that the trees had begun growth on the proper floor of the valley.

The main body of the bulletin is divided into three sections, as follows: (1) geologic and soil studies on the alluvial lands of the Red River Valley, by E. H. Sellards; (2) ecologic investigations, by B. C. Tharp; (3) physiographic investigations, by R. T. Hill. In the first section, the most interesting and important studies had to do with the age of the river valley as indicated by the series of dunes and by the growth of trees. While the latter gave the most dramatic evidence, the former constituted a distinct contribution to the physiography and soils of a river system. With regard to the sand-dunes, it was found that their formation is determined by the source of the sand rather than by the direction of the controlling winds, and that they are built on the land as a rule and not on the sand-bed of the river. Dune development in the Big Bend area has not been a haphazard matter, but the dunes fall into four definite series, representing four different periods, probably corresponding to as many successive dry phases of the climatic cycle. The first or oldest series lies close to the Texas bluff, and the last or newest one parallels the sand-plain of the stream. The relative age of the several series is indicated by their position, vegetation and soil, all of which were found to be in entire agreement. The most novel evidence was obtained from the mechanical analysis of the top soil of the successive series, which gave 1 per cent. of finest material for the new dunes of series four, 5 per cent. for series three, 16 per cent. for two and 20 per cent. for series one, the oldest. This increased fineness of the top soil with age is explained by the progressive disintegration of soil particles, the addition of organic matter, and the accumulation of dust particles, and is in complete accord with the successional advance of the plant communities.

The age of the valley was further indicated by the thickness of the soils in relation to the age of trees growing in them and especially by the ring-counts of trees found on the alluvial fans. By determining the depth of soil above the river sand and the amount of fill above the main roots of the trees, it was possible to use the ring-count to approximate a period of four or five hundred years since the tributary began to accumulate a fan on the valley land. The study of the

habits of the river in building its valley led to the conclusion that this was regularly in accordance with the process of accretion by which each new area more or less completely enclosed the older, and that the life-cycle of each individual valley could not be completed in the brief span of a single century.

The ecologic investigation of the Big Bend area was carried out principally by means of transects to determine the successional relations of the various communities from the Texas to the Oklahoma bluff, and by means of ring-counts of the trees scattered over the floor of the valley. The species were listed along each transect in accordance with their importance and then grouped in tables to facilitate comparison between the various localities. This not only rendered possible a complete outline of the development of the climax association in the region, but also afforded a definite comparative basis for the age of different portions of the valley in terms of the climax on the bluffs at either side. Of striking value is the analysis of the cottonwood stage in the succession and its indications for the age of the area occupied. The results of the serial study are in entire accord with those obtained by the reviewer for the dune areas of the river valleys of Oklahoma and of other rivers in the semi-arid and arid regions.

Ring-counts were made of 31 trees of various species which grew scattered over the valley floor. These were chiefly elm and cottonwood, with occasional pecan, ash, hackberry, etc. A third of the individuals gave ages ranging from 100 to 175 years and thus established beyond question the minimum age of the greater portion of the valley as considerably beyond one hundred years.

The results of the ecologic investigation are summarized as follows: The climax stage of the vegetation for the Big Bend region is the short-grass plains modification of the mixed prairie association.

The treeless portions of the valley have virtually reached the climax stage, as is indicated by comparing their vegetation with that of the bluffs on both sides of the river.

While the length of time required for a given area to pass from the initial stage to the climax can not be definitely stated in years, there is much evidence to support the view that it must take at least several hundred years, for example:

(1) Upon a tract on the Oklahoma side above Granfield Bridge, which in its oldest portion must have exceeded 100 years, only ten climax dominants had become established.

(2) At the southernmost limit of the cottonwood savannah, estimated to be more than 150 years of age, only five of a total of 18 climax dominants noted for the valley in this area had appeared.

(3) Using the cottonwood savannah as a basis for judgment, it seems entirely conservative to estimate 150 years as the minimum time required for the cottonwood stage to pass from initiation to extinction.

(4) There is no evidence of closer correlation between the age of the oldest trees in the valley and the maximum age of the soils that support them than there is between the ages of the trees and soils of the uplands along the river.

The conclusion from the studies of the life-history of the Red River is that the alleged islands, as the windrow-like fringing dunes were considered, are not islands at all but land-made features built on the valley-floor at times when a wide strip of flood-plain existed between channel and bench. Therefore, they have never been islands, and there is no ground for the assumption that the valley has been formed by a process of island building.

The maps that accompany the report are of a uniform excellence, and leave nothing to be desired in the matter of scale, execution or detail. From the standpoint of the ecologist they may be regarded as model base-maps for accurate quantitative work in succession.

The ability of the court to weigh scientific evidence accurately and to discriminate between presumption and proof is clearly shown by the following excerpts from the text of the decision:

> The valley land has always been dealt with as upland. . . . Through the long period covered by this course of action there never was any suggestion that this valley land was part of the river bed, nor that the shifting elevations of sand within the sand bed were the river's banks, nor that the land on the south side belonged to the United States. Not until some land on the south side and part of the river bed were discovered to be valuable for oil was this unbroken course of action and opinion drawn in question. However much the oil discovery may affect values, it has no bearing on the questions of boundary and title.
>
> The boundary as it was in 1821, when the treaty became effective, is the boundary of to-day, subject to the right application of the doctrines of erosion and accretion and of avulsion to any intervening changes.
>
> There are no surveys or records depicting the situation in 1821; nor are there any human witnesses who knew this part of the river then. But there are inanimate witnesses, such as old trees, which tell a good deal. At that place the river makes a pronounced but gradual bend to the north and back to the south. The area in question is on the inner side of the bend. It is larger now than 60 years ago, but how much is uncertain. The enlargement is the result of intervening accretions. The habit of the river is to erode the outer bank of a bend and to accrete to the opposite bank. . . . On the outer part are physical evidences of the formation being comparatively recent. On the inner part are like evidences of the formation being old, among them being the presence of living trees more than a century old. One of the trees,

a pecan, attained an age of 170 years. . . . To overcome the inference arising from the presence of the old trees, which were well scattered, testimony was presented to show that in 1821 these trees were all on islands, which afterwards were consolidated amongst themselves and with the lands on the south side. We think this testimony is essentially speculative and not a proper basis for judgment. In this area, as elsewhere in the valley, a succession of depressions is found at the foot of the bluffs and some testimony was produced to show that in 1821 the river, or a part of it, flowed there. It may be that the river was there long ago, but the testimony that it was there in 1821 is far from convincing. Our conclusion is that the claim that the river, or any part of it, ran south of this area in 1821 is not sustained. So the boundary follows the cut bank around the northerly limit of the area.

The perusal of the thousands of pages of testimony leads to the conviction that scientific experts should be appointed by the court and not employed by the litigants. This fact has already been emphasized by one of the scientists concerned (*Geog. Rev.*, 13: 188), who points out that the present practice fosters bias and discounts the spirit of scientific research (*cf.* also SCIENCE, 45: 147, 292). Indeed, it would seem that such cases as the present should not be matters of court procedure at all, but should be left to the decision of a disinterested scientific commission.

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## SPECIAL ARTICLES

### THE CHROMOSOME COMPLEXES IN THE SOMATIC CELLS OF MALE AND FEMALE OF THE DOMESTIC CHICKEN

IN publishing the rough notes and drawings of the late Miss Stevens on the spermatogenesis of the domestic fowl, Miss Alice Boring points to the insufficiency of our knowledge of the chromosome complex of birds. This state of affairs, together with the intensive work on the genetics of fowl which has been going at the Anikovo Genetical Station of the Moscow Institute of Experimental Biology, induced Professor N. K. Koltzoff to offer this theme to me for further investigation. This work began in the summer of 1922 and was conducted on embryological material, as well as on the testicles of young and adult cocks. Last summer I also investigated some other birds of the family *Passeres*.

Some fundamental results of my investigation had already been reported at the conference of the Anikovo station last June and published as a footnote in the Russian translation of T. H. Morgan's "Physical Basis of Heredity," and the drawings of the chromosome complex of the fowl were amongst the other exhibits of the Anikovo station at the Russian Agricultural Exhibition (inaugurated on August 15), when Number 1491 of SCIENCE (of July 27, 1923) with the stimulating article of Miss Boring came to my hands. The following discoveries confirm some results of Miss Stevens and contain also some quite new facts.

The fundamental results of my investigation can be briefly summed up in the following points:

(1) The somatic complex of chromosomes in fowl of the same sex is characterized by a complete uniformity in all tissues of the embryo.

(2) The chromosome complex consists of chromosomes of very different lengths, whereas the thickness of all chromosomes when properly fixed and colored is quite the same and is nearly equal to 0.5 $\mu$. The shortest are from one fifth to one sixth the length of the longest, which may attain nearly 3 $\mu$ (see the chromosomes X, x, B and b in the given drawings). The ordinary form of the chromosomes in the somatic cells is rod-shaped. One may see that any windings, which are to be observed in the longest chromosomes in the equatorial plates, should disappear in the metakinesis stage, when all chromosomes become straight.

(3) In the equatorial plate, at first, when the chromosomes are lying very near one another, they have a very regular and constant position. Their disposition is very characteristic, the longer ones lying outside and the smaller ones inside, as has been shown also by Miss Stevens in her drawings (Figs. 1 and 2). The elements of the outer circle lie in a more or less radial arrangement. Moreover, a very essential circumstance appears here, namely, that the long chromosomes have a tendency to a symmetrical disposition, every long chromosome on the right having its homologue on the left; this is to be particularly noticed in the early equatorial plates and likewise in the daughter plates in the males. This makes the pairs easier to find, especially in the case of the long chromosomes of the outer circle. In figures 1 and 2 the paired chromosomes of the right are designated by letters, A, B, C, and those of the left by small ones, a, b, c. A detailed study of the chromosome complexes of the male and the female lead me to designate these pairs with signs different from those given in Miss Boring's drawings.

(4) The constancy and symmetry of position of the chromosomes may also be observed in some degree in the pachytene spireme, which after the dissolution of the nuclear membrane spreads very regularly like a parachute, whose meridional ribs are lying like the long chromosomes of the outer circle.

(5) In consequence of the small size and comparatively large number of chromosomes in the fowl it is difficult to count them precisely. I have tried, however, to count the chromosomes in many mother and

daughter plates in different tissues of 15–17 day old embryos, whose sex had been positively determined by the examination of their gonads, and in view of this I consider the following results as quite established:

(A) In the homozygous male sex of fowl the chromosomes in the somatic cells appear to be paired (in respect to type) and their number is equal to 32 (see my figure I and Miss Boring's figure 2). The same complex with all its peculiarities is to be found also in the primitive generative cells and in the spermatogonia.

(B) In the heterozygous female sex the somatic complex of chromosomes differs from that of the male sex in that here one of the longest chromosomes (an X-chromosome) is not present; in its place there is usually to be observed a small Y-chromosome which, however, is not always distinct in the equatorial plate.

(C) The male complex consists therefore of 30 autosomes + 2 X-chromosomes, and the female complex of 30 autosomes + X + Y-chromosomes.

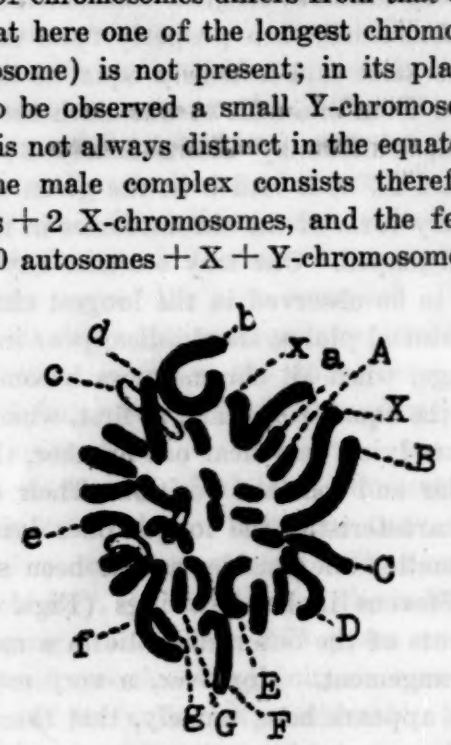


FIG. 1. Male

A comparative study of male and female complexes shows that the X-chromosome is among the longest of the chromosomes and lies in the outer circle of the equatorial plate near chromosome B (or the corresponding chromosome b of the left side), at the upper end of the axis that divides the equatorial plate into right ("paternal") and left ("maternal") sides. In the male the behavior of both X-chromosomes during all mitotic processes is not influenced by the behavior of the neighboring autosomes and they remain side by side between the chromosomes B and b. In the female, however, the unique X-chromosome always lies at first between the autosomes B and b in the early equatorial plate, as in the male, but later on it changes its place, evidently under the influence of the reciprocal attractions of both corresponding chromosomes B and b, and it may come to occupy any position, as in figure 2. Sometimes it lies quite isolated outside the outer chromosome circle. This often makes the configuration of the female equatorial plate less regular than that of the male one.

(6) The chromosome complexes of the different Passerine birds studied appear to be very similar to that of fowl in their chief characters; this induces us to believe that this complex is peculiar to most birds.

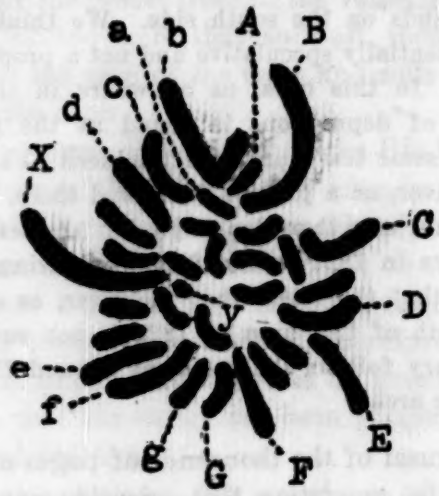


FIG. 2. Female.

In drawing the figures given a camera lucida was used, together with an apochr. oil immersion 2 mm. (Zeiss) and No. 18 compound ocular.

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## NOTE ON THE AVERAGE NUMBERS OF BROTHERS AND OF SISTERS OF THE BOYS IN FAMILIES OF N CHILDREN

THE question to be answered in this note was brought to my attention by Dr. J. McKeen Cattell. That the question presents a point of interest may be accepted from the fact that a scientist with the keen statistical intuition of Francis Galton seems to have drawn an incorrect inference where this question was involved (see Cattell and Brimhall, "American Men of Science," 1921, p. 804). Galton in his "Hereditary Genius" says: "I also have found the (adult) families to consist on the average of not less than 2½ sons and 2½ daughters each. Consequently, each judge has on the average 1½ brothers and 2½ sisters." As stated in "American Men of Science," "It seems to most people obvious that if there are equal numbers of boys and girls, a boy must on the average have one more sister than brother." Thus, the statement quoted from Galton would be regarded as obvious by most people. Dr. Cattell pointed out the error in this view, and clearly demonstrated for families of two children the fact that the boys have on the average as many brothers as sisters. It is the object of this note to demonstrate the fact stated by Cattell for families of any size, say families of n children each, in which boys and girls occur on the average in equal numbers. That is, assuming that ½ is the probability that a child taken at random

| (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|
| Number of Brothers | Number of Sisters | Frequency | (1) × (3) | (2) × (3) |
| 0 | n — 1 | kn | 0 | kn(n — 1) |
| 1 | n — 2 | kn(n — 1) | kn(n — 1) | kn(n — 1)(n — 2) |
| 2 | n — 3 | kn(n — 1)(n — 2) / 2! | kn(n — 1)(n — 2) | kn(n — 1)(n — 2)(n — 3) / 2! |
| " | " | " | " | " |
| " | " | " | " | " |
| " | " | " | " | " |
| " | " | " | " | " |
| n — 3 | 2 | kn(n — 1)(n — 2) / 2! | kn(n — 1)(n — 2)(n — 3) / 2! | kn(n — 1)(n — 2) |
| n — 2 | 1 | kn(n — 1) | kn(n — 1)(n — 2) | kn(n — 1) |
| n — 1 | 0 | kn | kn(n — 1) | 0 |
| | Totals | $kn\ 2^{n-1}$ | $kn(n-1)2^{n-2}$ | $kn(n-1)2^{n-2}$ |

from the group is a boy, it will be proved that $(n-1)/2$ is the most probable value of the arithmetic mean of the number of a boy's brothers, and likewise of the number of his sisters. Consider a large number N of families and for convenience assume that N is a certain number of time $2^n$, say $N = k2^n$. Then the *a priori* most probable numbers of families with 0, 1, 2, : : :, n boys is given, respectively, by the terms k, kn, $kn(n-1)/2!$, : : :, $kn(n-1)/2!$, kn, k in the binomial expansion of $k(1+1)^n$.

First note that k families out of $k2^n$ have no boy; second, that kn families have only one boy each and therefore they have kn cases of no brothers and n — 1 sisters; third, that $kn(n-1)/2!$ families have two boys each, and hence they have kn(n — 1) cases of one brother and n — 2 sisters; fourth, that $kn(n-1)(n-2)/3!$ families have three boys each, and hence they have $kn(n-1)(n-2)/2!$ cases of two brothers and n — 3 sisters; and so on. The manner of the distribution seems sufficiently clear without further illustration.

Then we set up the ordinary form for finding the arithmetic means of the number of brothers and of the number of sisters in the accompanying table.

The totals of columns (4) and (5) are equal, and each divided by the total of column (3) gives $(n-1)/2$. Hence $(n-1)/2$ is the arithmetic mean of the number of brothers, and of the number of sisters.

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## THE AMERICAN CHEMICAL SOCIETY

### DIVISION OF ORGANIC CHEMISTRY

*(Continued)*

*The electrochemistry of free radicals:* J. B. CONANT, L. F. SMALL and A. W. SLOAN. The halochromic salts of triaryl and diaryl carbinols are rapidly reduced in acetic acid solution by vanadous salts to the corresponding ethanes which can be obtained in good yields. If these ethanes are dissociated with the formation of free radicals, a significant potential of the process can be measured by the titration method, or by mixing the free radical and the halochromic salt. Similar results can be obtained with certain more stable xanthylium salts even in an aqueous and alcoholic solution. These potentials are the equivalent of the single electrode potentials of the metals, and vary according to the nature of the free radical. The reduction of halochromic salts to free radicals is being used to prepare free radicals hitherto inaccessible; benzylxanthyl has been thus obtained.

*Condensation of phthalic anhydride with aryl hydrocarbons:* O. R. QUAYLE and E. E. REID. The condensation of phthalic anhydride with aromatic hydrocarbons containing fluorine has been studied, and a number of fluor-benzoyl-benzoic acids prepared. These have been condensed to form the corresponding substituted anthraquinones.

*Condensation of cyclohexanone with aldehydes:* C. E. GARLAND and E. E. REID. Cyclohexanone has been condensed with p-toluic aldehyde, p-brombenzaldehyde, furfural and anisic aldehyde. The complex ketones have been hydrogenated and also subjected to the Grignard reaction. The tertiary alcohols so formed have been dehydrated and the unsaturated hydrocarbons hydrogenated.

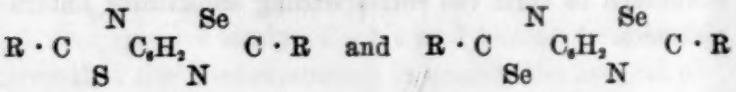
*Reactions of unsaturated 1, 4 diketones:* J. B. CONANT, R. E. LUTZ and L. F. LEA. Dibenzoyl ethylene and its derivatives combine with ammonia, aniline, malonic ester (in the presence of sodium alcoholate), hydrogen chloride, acetyl chloride and acetic anhydride yielding substituted 1, 4 diketones or, in certain cases, substituted furans; from the former, pyrrols can be prepared. Dibenzoyl ethylene dibromide easily loses two molecules of hydrogen bromide when treated with alkaline reagents; the resulting dibenzoyl acetylene combines at once with water, alcohol or phenol according to the nature of the reagent

employed. The product in the first instance is a strongly enolic 1, 2, 4 triketone.

*Benzylpseudothiourea salts of naphthalene sulfonic acids:* R. F. CHAMBERS and P. C. SCHERER. The method of preparation of the benzylpseudothiourea salts of a series of the more common mono and disulfonic acids of naphthalene is given, and these salts have their properties described. The melting points, solubility curves in n/5 HCl, solubilities in organic solvents, crystal forms and water of crystallization have been determined and are described. On account of their extreme ease of preparation and definite melting points, these compounds are suggested as a means of identification of the naphthalene sulfonic acids.

*Reduction potentials of polycyclic anthraquinones and the structure of anthracene:* L. F. FIESER. The reduction potential of ang. benzanthraquinone ($\pi_0 = 0.226$) in alcoholic solution is considerably higher than that of anthraquinone ($\pi_0 = 0.155$) while lin. benzanthraquinone can not be reduced by zinc dust and boiling alkali, and attempted measurements indicate a reduction of potential of less than 0.100v. This difference in the effect of the phenylene group on the potential of anthraquinone, exhibited also in the dibenzanthraquinone series, is interpreted on the basis of the ortho-quinonoid structure of anthracene and the comparison of the properties of the quinonoid systems of the anthrahydroquinones in question with the properties of true quinones.

*Researches on the selenium compounds—III. The synthesis of benzo-bis-selenazoles and thiazylbenzoselenazoles, new heterocyclic systems. The preparation of a selenium derivative of cinchophen type:* M. T. BOGERT and H. H. HOPKINS. Benzalamino benzoselenazoles when fused with sulfur or selenium yield the following heterocycles:



The thiazylselenazole adds bromine or acetyl chloride, and is easily nitrated. The bis-selenazole exhibits properties similar to those of the simple benzoselenazoles. Such bis-selenazoles also result from the fusion of the dibenzal derivatives of phenylene diamines with selenium. The 6-furalamino-2-phenyl-benzoselenazole is decomposed by fusion with either sulfur or selenium. From 6-amino-2-phenyl-benzoselenazole, the corresponding 6-cyano and 6-COOH derivatives were prepared, the latter being a selenazole analog of Cinchophen (Atophan), resembling the thiazole compound described by Bogert and Abrahamson (*J. A. C. S.*, 44, 826 (1922)).

*Researches on quinazolines—XXXV. Stereoisomeric styryl derivatives of some 4-quinazolone alkyl iodides, and their bearing upon the problem of photosensitizing dyes:* H. CLARK and M. T. BOGERT. (1) Great difficulty was experienced in the preparation of alkyl iodides of 2-methyl-quinazolines, although the corresponding derivatives of 2-methyl-4-quinazolones were obtained easily. (2) The non-reactivity of 2, 4-dimethyl-quinazoline with aromatic aldehydes is at variance with certain recent hypotheses concerning reactive methyl groups of nitrogen heterocycles. (3) Attempted "cyanine condensations" with 2-methyl-4-quinazolone alkyl iodides resulted negatively. (4) 2-Methyl-4-quinazolone alkyl iodides were condensed with p-dimethylamino benzaldehyde in the presence of acetic anhydride or piperidine, yielding the corresponding styryl derivatives. (5) Cis and trans forms of these styryl derivatives were separated by fractional crystallization from methyl alcohol. The two forms differed widely in appearance and in melting point. (6) The lower melting (labile) isomer was convertible into the higher melting (stable) one, but the reverse change could not be effected. (7) The products were devoid of photosensitizing properties and valueless as dyes. (8) The two stereoisomers gave identical mono-bromo dibromides when treated with bromine in chloroform solution. (9) In the course of the work, the following new compounds were prepared: cis and trans forms of the methyl iodides of 2-p-dimethylaminostyryl-4-quinazolone, of 3-methyl-4-quinazolone, of 3-ethyl-4-quinazolone, also of the ethyl iodides of 3-methyl-4-quinazolone, and their bromination products.

*The preparation of oxindole derivatives from isatin:* A. J. HILL and A. S. SCHULTZ. Isatin, as well as its mono and dibrom derivatives, will condense with the activated methylene groups of diketopiperazine and hydantoin. The reduction and subsequent hydrolysis of these new condensation products should theoretically lead to the formation of oxindole amino-acetic acid (A), or oxindole acetic acid (B) and the corresponding halogen derivatives.

(A) $C_6H_4(NH \cdot CO : CH) — CH \cdot NH_2 \cdot COOH$
(B) $C_6H_4(NH \cdot CO \cdot CH) — CH_2 \cdot COOH$
(C) $C_6H_4(NH \cdot CO \cdot C) : CH \cdot COOH$

From the unsubstituted isatin condensation products, the writers have obtained (B) and its unsaturated homolog (C), depending upon the reagents employed. The amino acid has not been isolated, since deaminization occurs, even when mild hydrolytic agents are employed. Oxindole acetic acid may be obtained from (C) by reduction. The former is readily brominated in sulfuric acid solution. This method for the synthesis of oxindole derivatives is being extended to include not only the brominated, but also the iodated types which are somewhat related to thyroxin in their molecular configuration.

*The substituted thioureas—V. The synthesis of thiazolidine derivatives:* F. B. DAINS, R. Q. BREWSTER, I. L. MALM and A. W. MILLER. (a) The synthesis of alpha-aryl (or alkyl)-alpha-ethanol-beta-alkyl (or aryl) thioureas. $RN(CH_2CH_2OH)CSNHR'$ from the substituted aminoethanols and mustard oils. (b) The conversion of these thioureas into thiazols of known structure. (c) The formation of thiozolines from ethylene dibromide and thioureas of the type RNHCSNHR', where R and R' are different groups. (d) Some di-thio-ethylene ethers from aryl-alkyl thioureas.

*The oxidation of carbohydrates with air:* H. A. SPOEHR. Thus far it has been possible to oxidize the hexoses with air only in alkaline solution. While disodium phosphate catalyzes the oxidation of glucose with $H_2O_2$, it does not affect the oxidation with air. Glucose and other hexoses are oxidized with the formation of $CO_2$ by air in solutions containing $Na_2HPO_4$ and methylene blue. This reaction is greatly accelerated by small amounts of Fe salts. Sodium ferro pyrophosphate is a more active catalyst for the oxidation of carbohydrates than methylene blue. Not only are the hexose sugars thus oxidized, but sucrose, trehalose and other compounds which do not reduce Fehling's solution are easily oxidized. From a consideration of the rates of oxidation of different hexoses, it appears that glucose is first converted into levulose by the $Na_2HPO_4$.

*The lactones of l-mannonic and d-mannonic acid:* F. W. UPSON and L. SANDS. Nef and Hadenburg have shown that there are two d-mannonic acid lactones, one of specific rotation plus 112° and changing rapidly in solution to a rotation of about plus 28°. Nef called this provisionally the beta-lactone. The gamma-lactone, rotation plus 53°, changes very little in solution. We have the analogous lactones of l-mannonic acid. Further, we have shown that Nef's beta-lactone possesses in all probability a pentylene-oxide structure and that, further, the sugar, d-mannose, possesses also a pentylene oxide ring structure.

*Separation of alpha and beta amylose. Properties of alpha and beta amylose:* T. C. TAYLOR and H. A. IDDLES. A study has been made of the possibilities of separating the alpha and beta components of corn starch through the agency of the electric current. Alpha amylose wanders to the positive electrode, while the beta amylose remains dispersed. The solution of the beta amylose can be decanted from residue of the alpha which collects in compact mass. Proper treatment of these two components gives the respective amyloses. The alpha contains 1.25 per cent. combined fatty acids, while the beta is apparently pure carbohydrate. The latter amylose goes into "solution" in water heating, to the extent of at least 6 per cent. It gives a pure blue color with iodine-iodide solutions and is very quickly hydrolyzed by malt diastase. Detailed investigation of the properties of these two components are under way.

*Identification of fatty acids liberated by hydrolysis of corn starch:* T. C. TAYLOR and L. LEHRMAN. Oleic acid and linoleic acid have been identified by their oxidation products and bromides as being the unsaturated fatty acids which together with palmitic acid are liberated by the acid hydrolysis of corn starch.

*The catalyzed oxidation of galactose:* E. C. WHITTIER. This oxidation by nitric acid is of interest in connection with the production of mucic acid from milk sugar or galactose. Vanadium pentoxide was the only substance tested that accelerated the oxidation of galactose by nitric acid. Thirty-five to forty per cent. is the optimum range of concentration of nitric acid for mucic acid production at 85°. Both higher concentration of oxidizing agent and addition of vanadium pentoxide increase the production of oxalic acid and carbonic acids at the expense of mucic acid.

*The extraction of maltase from yeast:* V. K. KRIEBLE, E. L. SKAU and E. W. LOVERING. Previous investigations on maltose from yeast have shown that an acid is formed in the extraction, but have disagreed as to the best method of extraction, and the treatment of yeast previous to extraction. Our experiments have shown that maltase can be extracted either from fresh or dry yeast, a more active extract being obtained from dry yeast, and that the strength of the extract depends on the condition of the yeast, the length and temperature of extraction, and the $P_h$ of the extractive medium. Maltase even at 15° is destroyed gradually in the extractive medium so that, as the extraction progresses, the activity of the extract rises to a minimum and then decreases—the rate of decrease being influenced by temperature and the medium of extraction.

*Preparation of tartaric acid from maleic and fumaric acids* (By title): N. MILAS and E. M. TERRY. The K. A. Hofmann method of oxidating maleic and fumaric acids to meso tartaric and racemic acids, respectively, has been materially improved by a study of the variation of yield at different hydrogen ion concentrations. The catalyst, osmium tetroxide, can be removed and reused. The mechanism of the reaction will be given in brief.

*A study of directing influence of substituents in the benzene ring by means of rate of bromination:* J. JOHNSON, A. J. HILL and A. W. FRANCIS. Amino and phenolic compounds in aqueous solution are brominated rapidly in all available ortho and para positions. The rates are influenced greatly, however, by other substituents in the ring. The absolute velocities are far too great to be measured directly, but consistent relative rates have been estimated by means of a series of partition experiments, allowing insufficient bromine to react simultaneously with two compounds, and analyzing the products. In this way measures of the relative velocity of bromination in all positions of about 35 benzene derivatives have been ascertained. A comparison of the influence of the several groups under various conditions is thus possible.

*A simple relation between composition and boiling point of organic liquids:* E. Q. ADAMS. Longuinescu found an appropriate relation for normal organic liquids between the absolute boiling point, density of no. of atoms in the molecule: $T\sqrt{(D\,V\,n)} - 100$ approx. An even more exact expression, not involving density, has been found. If the elements be weighed according to the row in the periodic table in which they occur (system of Rydberg), *i.e.*, H is disregarded; C, N, O, F count 1; Si, P, S, Cl, 2, etc., the relation T equals to the square root of 2000n holds within one unit of "n" for most organic liquids, and for many inorganic nonelectrolytes.

*The chlorination of 2-amino-p-xylene:* A. S. WHEELER and M. MORSE. 2-Amino-p-xylene was converted into its acetyl derivative and chlorinated at a low temperature. Chlorine was substituted in position 5. This was proven by converting it into 2, 5-dichloroxylene and oxidizing this to 2, 5-dichloroterephthalic acid. A new series of azo dyes was prepared by diazotizing 2-amino-5-chloro-p-xylene and coupling it with the following phenols: phenol, resorcinol, thymol, alpha-naphthol, beta-naphthol, Schaeffer's acid and Cleve's acid. Other dyes are in the course of preparation.

*Borneol in spruce turpentine:* A. S. WHEELER and C. R. HARRIS. The dark liquid residue left after removing most of the p-cymene from spruce turpentine by steam distillation was subjected to fractional distillation in vacuo. Direct heat was applied and a pressure of 3 mm. Using 900 cc of liquid, 400 cc proved to be p-cymene, b. p. 42°. The remainder was collected in 5 or 10 cc fractions, the last fraction collected boiling above 100° or above 300° at atmospheric pressure. All fractions were liquid except one boiling at 75–80° or 205–210° at atmospheric pressure. This was white crystalline compound of terpene-like odor (melting point 205° after recrystallizing). Analysis gave the formula $C_{10}H_{18}O$ corresponding to borneol. The melting point, crystalline form and solubilities also suggested borneol. Its phenyl-isocyanate gave the melting point of 141°, the same as that of borneol. The specific rotation, however, was $-12° 43'$. This indicated l-borneol mixed with considerable of the dl-form.

*Preparation of malic acid from maleic acid* (By title): E. M. TERRY and L. EICHELBERGER. A method for the quantitative estimation of malic acid in the presence of maleic acid was first developed. Then a survey was made of the effect of different salts on the rate of addition of water to the double bond of maleic acid. Many salts were found helpful. The rate of the change when mercuric acetate was catalyst was studied in detail and an efficient method established for the preparation of malic acid from maleic acid. A theory of reaction will be given.

*Study of nitration of benzoic acid* (By title): H. M. SEVERANCE and E. M. TERRY. A study was made of the products of nitration of benzoic acid when the process was carried out first, with nitric acid with varying water content, and second, with pure nitric acid in acetic acid solution. For this purpose a new method was developed for analyzing mixtures of ortho and meta nitro benzoic acid in the presence of benzoic acid. This method is briefly outlined together with the results of the study.

*Bromination of sodium benzoate* (By title): E. M. TERRY and L. EICHELBERGER. Sodium benzoate was brominated by a new process. For the purpose of establishing the identity of the isomeric acids formed, a special method of analysis was developed. Finally good working conditions were found for the preparation of isomeric monobrombenzoic acids. It may be shown that the methods of analysis and preparation have a variety of possible applications. The mechanism of the reaction together with an outline of the above processes could be given.

*Catalytic transmutation of maleic acid to fumaric acid* (By title): L. EICHELBERGER and E. M. TERRY. A new theory of the mechanism of the catalytic transmutation of maleic to fumaric acids is given. It is shown to correlate the widely diversified conditions under which the process may be carried out. New experimental work is given in support of the theory.

*Halogenation of maleic acid and of fumaric acid* (Lantern): E. M. TERRY and L. EICHELBERGER. A new method of bromination and of chlorination of the neutral salts of mono-carboxylic acids will be presented. With the help of this method in large measure we may bring about either cis or trans addition of halogen at the double bond of the acid as we desire. A theory of the mechanism of the processes involved has been developed. This theory may be shown to apply to the Walden Inversion as well as the above-mentioned processes.

*Condensation of carbon tetrachloride with phenol* (By title): M. GOMBERG and H. R. SNOW. We find that, contrary to Heumann's claim (D. R. P. 68,976), the condensation of carbon tetrachloride and phenol takes place at ordinary pressures, and a good yield of aurin is obtained. In addition to aurin, several other products are produced. All these have been identified. Procedures have been worked out whereby either diphenyl carbonate or di-hydroxy-benzophenone or trihydroxy carbinols may be obtained to the almost complete exclusion of the others. A convenient method has been devised for the complete separation and purification of aurin. The properties of the latter were determined and many derivatives of it obtained. It has also been established that the technical product contains only about 50 per cent. of aurin, and the nature of impurities has been determined.

*Unsymmetrical aliphatic arseno compounds:* C. SHATTUCK PALMER. Several members of this previously unrecorded series have been prepared by simultaneous reduction of equimolecular proportions of two different aliphatic arsonic acids with 50 per cent. hypophosphorous acid in the cold. The products can be obtained as yellow needles but have a marked tendency to become gummy. They are practically insoluble in water and most organic solvents. Those in which one of the groups attached to arsenic is substituted by carboxyl form water-soluble sodium salts. If proper conditions of reduction are not observed, a mixture of two arseno compounds is obtained instead of the unsymmetrical derivative.

*The effect of temperature on the equilibrium between benzaldehyde and benzoin:* ERNEST ANDERSON and LEROY G. STORY. The value of the equilibrium constant between benzaldehyde and benzoin has been determined experimentally at six different temperatures and the results found to agree closely in each case with the value calculated by means of the Van't Hoff equation.

J. A. NIEUWLAND,
*Secretary*